STORM STRIKE PROBABILITIES

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1. In a previous study of hurricane motion, the climatological experience of tropical storms in the period 1886-1963 was related to the track of Hurricane Cleo of August 1964. Storm movements within 5° squares centered on specific points along the path of Cleo will be investigated. Nine such 5° squares are shown in this first slide.

2. Considering only those storms which occur within two weeks before or after Cleo was at the center of the specific square, probability ellipses of positions of the tropical storms were constructed. The points shown on these figures are adjusted points. If a storm track passed through the shaded square but did not travel through the center, the track was adjusted to the center of the square and the end point of the 36 hour travel plotted on the path as it would be if it had passed through the center 36 hours previously. The top figure in this slide shows the 95 and 40% probability ellipses for adjusted positions 36 hours subsequent to passage through the center of the shaded square. This uppermost figure considers all storm tracks which passed through the square within two weeks before or after the calendar date of Cleo's location at the square center.

2A. The middle figure considers only half of these storms. All storm tracks were arrayed by 24 hour antecedent direction. The array was then split so that two samples were developed: one whose antecedent direction was from the north clockwise through one-half of the sample -- the adjusted end points and probability ellipses for this half of the sample are seen in the middle of the slide; the remaining 36 hour adjusted positions and probability ellipses for the other half of the sample -- for those storms whose antecedent directions were from more southerly or westerly -- are shown at the bottom of the slide. This simple stratification does alter the "target" position.

3. A similar set of ellipses for square #2 is shown here, with similar stratification by antecedent motion.

4. We will skip squares 3-8 and glance at the same type of figure for storm motion subsequent to recurvature. The total sample for

square 9 is seen in the top diagram and the stratified data are seen in the middle and lower pictures. Remember, the middle figure shows half of the storms whose antecedent direction is arrayed starting at the north and moving clockwise through 50% of the available data, and the bottom portion contains those storms with more westerly and southerly antecedent positions. The effect of stratification reverses the relation of the targets after recurvature.

5. Going back now to the total sample, the adjusted 36 hour positions were plotted and the bearing to the adjusted antecedent position was entered alongside each plotted end point. Then isolines of these bearings were constructed. These values for square 1 (on the bottom) and 2 and 3 (on the top) are shown here. The isopleths of antecedent bearing clearly demonstrate the stratification effect of this factor on subsequent storm motion.

6. Similar diagrams for squares 4, 5, and 6 are shown in this slide.

7. The last three squares studied are illustrated here.

8. Going back to square 1, 40 and 95% probability ellipses were constructed for 36 hour, 72 hour, and 108 hour movements, again using only those storms which occurred within two weeks before or after the date of Cleo. The 40% probability ellipses are shown in blue and the 95% ellipses in red for each of these three time periods. The track of Cleo is entered in black.

9. A problem often facing forecasters is "What is the probability that a hurricane or tropical storm now in existence will strike a specific target within some specified time interval?" Two questions can be considered here: (1) Where do storms come from to strike this target? - and (2) What is the probability that storms in this source region will strike this target?

The first question is illustrated here. Probability ellipses constructed on this slide are the initial positions of tropical storms or hurricanes which passed within approximately 60 nautical miles of Galveston. The top figure shows storm positions 36 hours prior to "strike" and the bottom figure shows storm positions 72 hours prior to "strike". All portions of the season are included in this sample, but only those storms which passed within the specified distance of the target.

10. Similar figures are shown here for those storms which passed within approximately 60 nautical miles of Miami, Florida, at 36 and 72 hours. We were looking here only at the question: "Of those storms

which passed within a specified distance of the target, what was their position 36 hours before strike and 72 hours before strike?" In other words, if we are concerned with the possibility of a storm striking Miami, from which quarter does the danger arise? These figures do not answer the question: "If a storm is in this area, what is the likelihood that it will strike Miami?" Both parts of the question must be investigated.

11. Continuing the investigation of the first part of the question, we looked at the previous positions of the storms which affected 11 cities. We defined the term "affected" geometrically by stating that any storm track which went through a square 2° of latitude on a side (with the city at the center) affected that city.

12. The 40% probability ellipses for the 36 hour prior positions of storms affecting 8 of the cities are shown here. The 40% ellipses and the cities are color-coded with comparable colors. Thus, this slide shows us the center of the area from which storms have traveled to affect these 8 cities in 36 hours.

13. Looking now at the question of "What is the danger of a strike for those storms located in a specified area?" we will go back to the data tabulated for the 9 squares used in the Cleo study, simply because these data were available to us and we have not yet taken the time to construct such figures for areas located at centers of the ellipses as shown in the last figure. Looking at square 1 and again only those storms within two weeks before or after Cleo's date, we can see the 40% ellipses (the shaded ellipse) for the 36 hour position and the probability that 36 hours after being in the center of the shaded square the storm position will be within the 2° square containing the city. Thus, storms centered now in the shaded square have a probability of .073 of being within 60 nautical miles of San Juan 36 hours from now and a probability of .004 of being within 60 nautical miles of Kingston, Jamaica, 36 hours from now.

13A. These values are probabilities for a given point and time, not cumulative probabilities for all points within a specified time interval, or for all times at a given point. Obviously, at San Juan this latter number would be larger than the number shown here, since the storms which passed through San Juan's square in the 36 hours would be included. They are not included in these point probabilities.

14. Skipping to square 4, we can see again the 40% probability ellipse for 36 hour future positions of storms centered now in the 5° latitude square. The probability that the storm will be within the

2° square about Key West in 36 hours is .08 and the probability that it will be in the 2° square about Miami in 36 hours is .03. Again, these are values of probability at a given point in time, rather than accumulated over the time interval.

15. The same information is shown here for storms within square 5. The probability that they will be within the 2° square about Key West is .005; for Miami, .01; for New Orleans, .003 and for Charleston, .023. We have not yet computed values for Tampa or Jacksonville, but they would obviously be substantially higher since we are considering the probability of a storm being at a specific point at a specified time. Again the 40% probability ellipses for the 36 hour position is shaded.

16. Let us go back to square 1 and look at these probabilities and the 40% ellipses for 36, 72, and 108 hours. We see here the same probabilities that we looked at a moment ago for the 36 hour strike likelihood and 40% ellipses for storms passing through square 1 within two weeks before or after Cleo's date.

17. Now, let us look at 72 hours after passage through this square. The probability at Kingston, Jamaica, is .025; at Havana, Cuba, .008; Key West, Fla., .004; Miami, .003; and less than 0 to three decimals at the other cities on the graph. At 72 hours after passage through the mid-point of the shaded square 40% of the storms may be expected to be within the stippled ellipse.

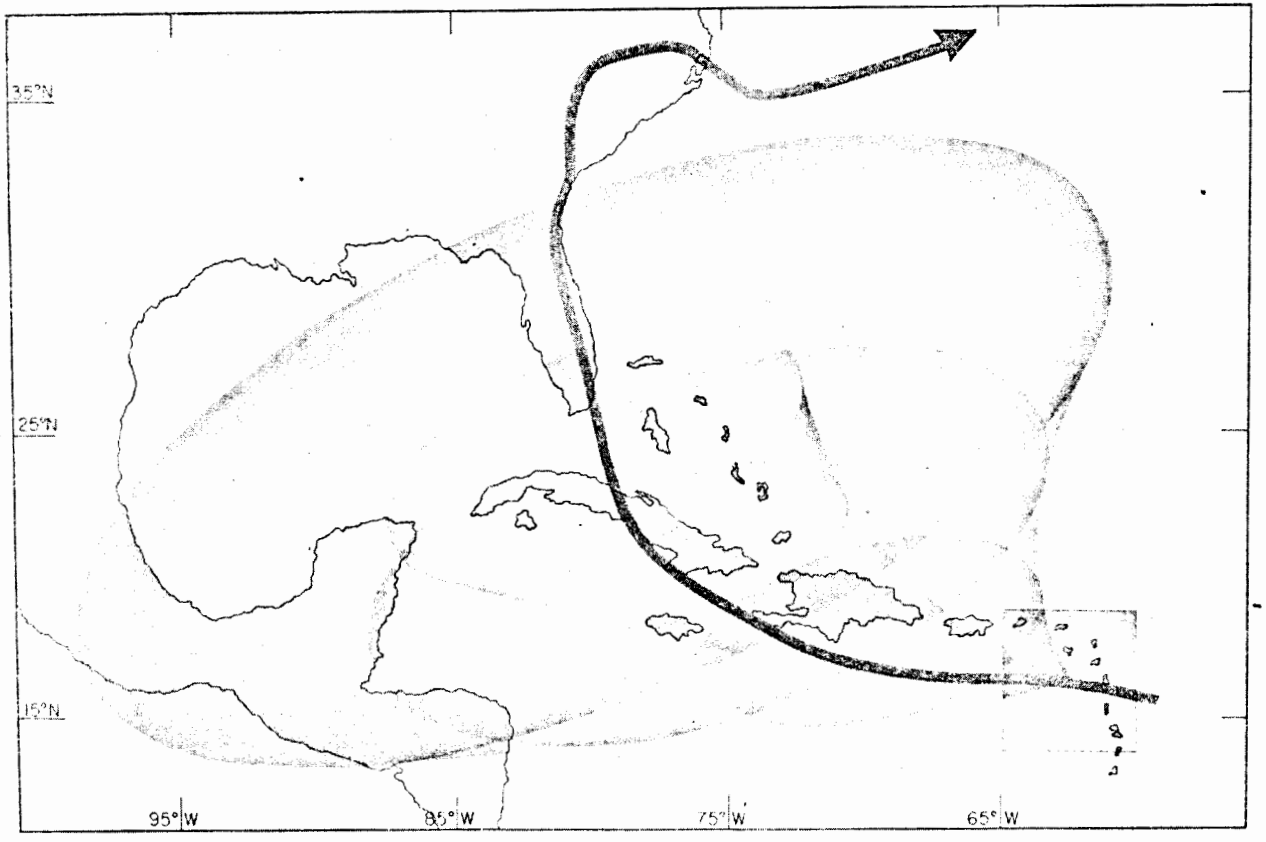
18. If we look into longer range prediction, again for square 1, we can develop the likelihood of the storm position being within the 2° square around these same cities after 108 hours. At Kingston, Jamaica, it is .003; .023 for Havana, Cuba; .023 for Key West; .022 for Miami; .001 for New Orleans; and .002 for Charleston. 40% of the storms passing through the center of the shaded square will, in 108 hours, be located within the stippled ellipses.

19. Using these data, one can construct a hurricane strike probability table. Such a table is shown here for these 11 cities and storms centered at each of the 9 squares for 36 hour movement and at square 1 for 72 and 108 hour movement. These data are shown as an example of the type of objective climatological analyses which can be made to determine a probability of storm strike for specific locations at specified times in the future for storms located in given locations. To construct such a table for all possible 5° squares and all segments of the season of tropical storm activity for all target cities would be a substantial undertaking, but is one which the forecaster might consider asking the climatologist to undertake if the forecaster is required to provide statements as to the probability of

storms affecting specific locations within stated time intervals.

19A. The figures contained here are not "within time intervals" but are at specified times. They are shown for purposes of illustration only. An accumulation of values for given times would yield the values for the probability of storm strike within a given future time interval.

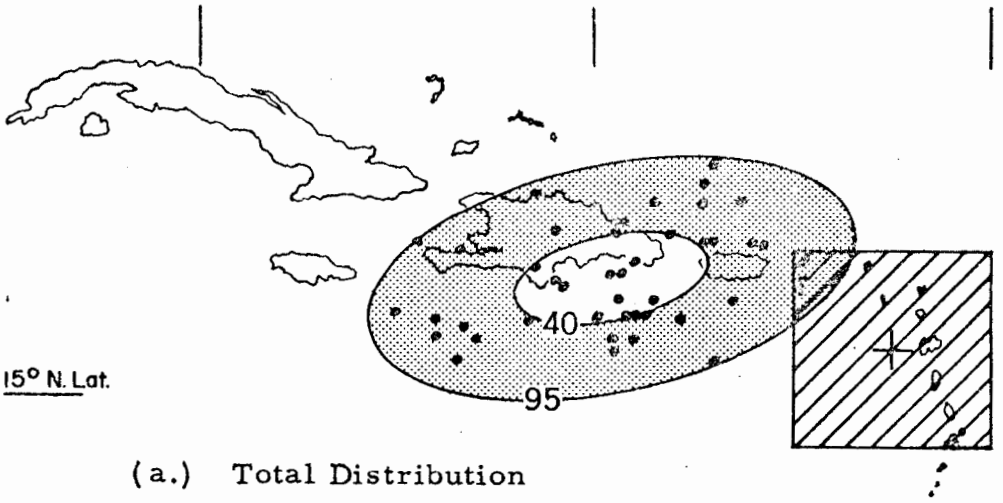
Probability Cones of 0.40 and 0.95 Probability of 36, 72, and 108-Hour Movement of Tropical Storms Passing Through a Five-Degree Latitude and Longitude Square Centered on the Path of August 1964 "Cleo"



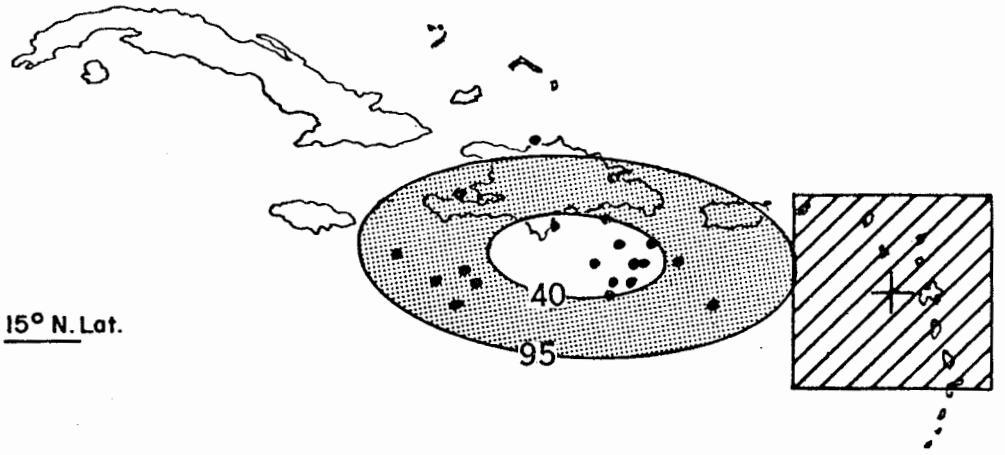
Square 1 - The most southerly and easterly five-degree square of the nine squares used in this study. Storms were moved to a point on "Cleo's" path in center of square from their closest 7 AM position.

HURRICANE POSITION PROBABILITIES FROM CLIMATOLOGICAL DATA

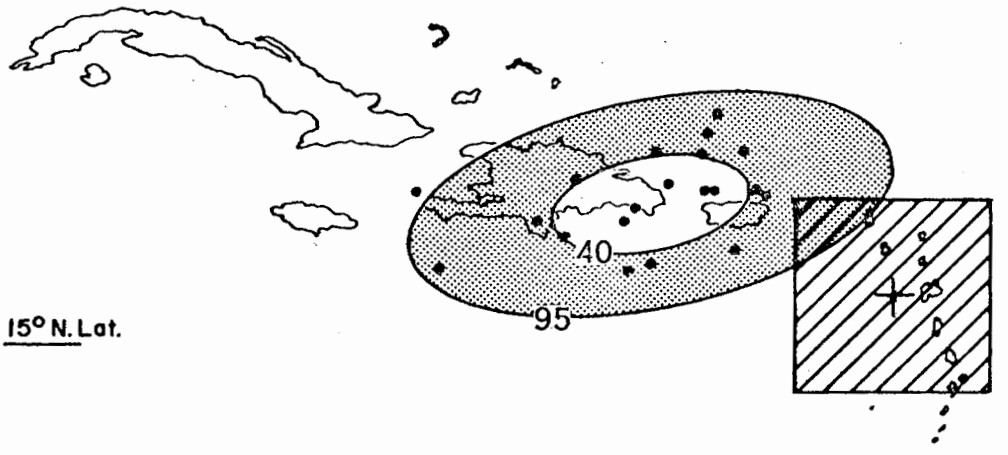
SQUARE 1



(a.) Total Distribution



(b.) Distribution of one-half of storms from an array of prior 24-hour "direction from" arrayed clockwise from north

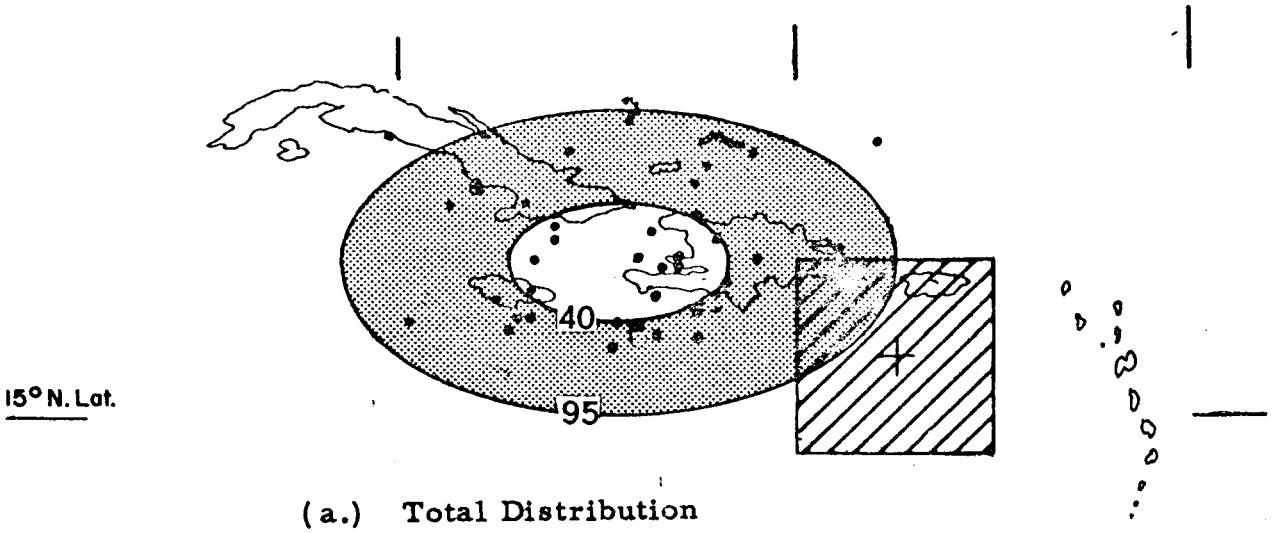


(c.) The remaining one-half of the storms (prior "direction from" further clockwise in array)

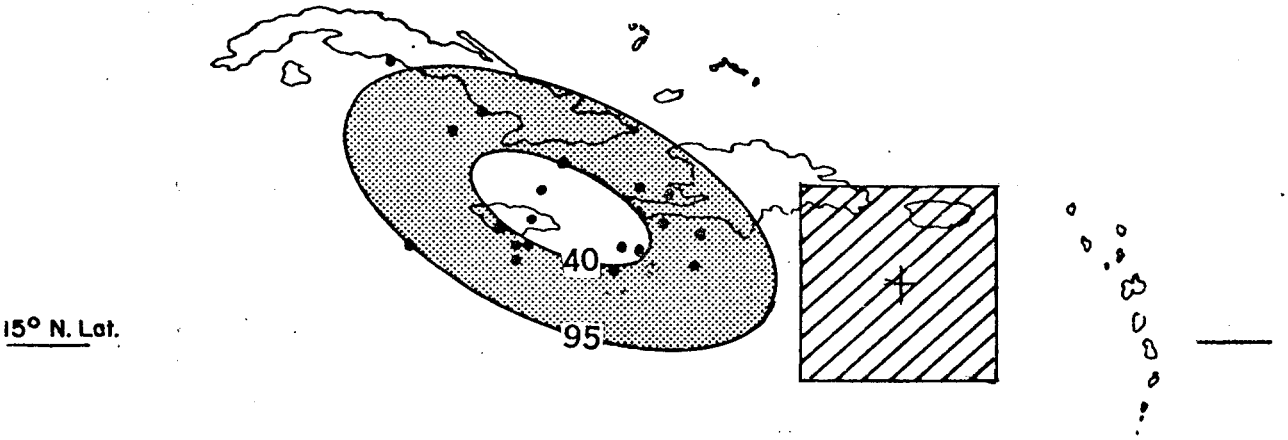
Figure 1. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".

HURRICANE POSITION PROBABILITIES FROM CLIMATOLOGICAL DATA

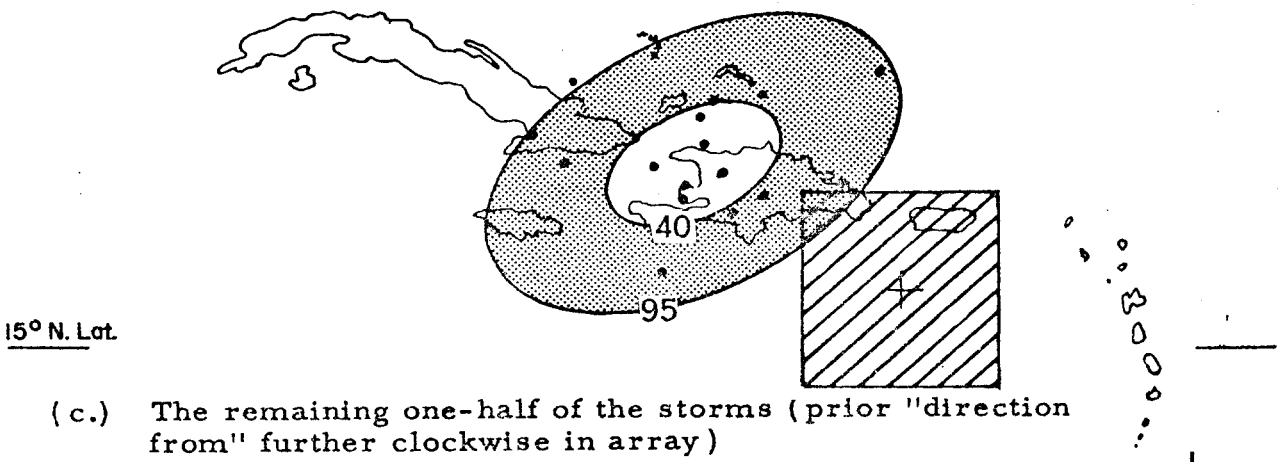
SQUARE 2



(a.) Total Distribution



(b.) Distribution of one-half of storms from an array of prior 24-hour "direction from" arrayed clockwise from north

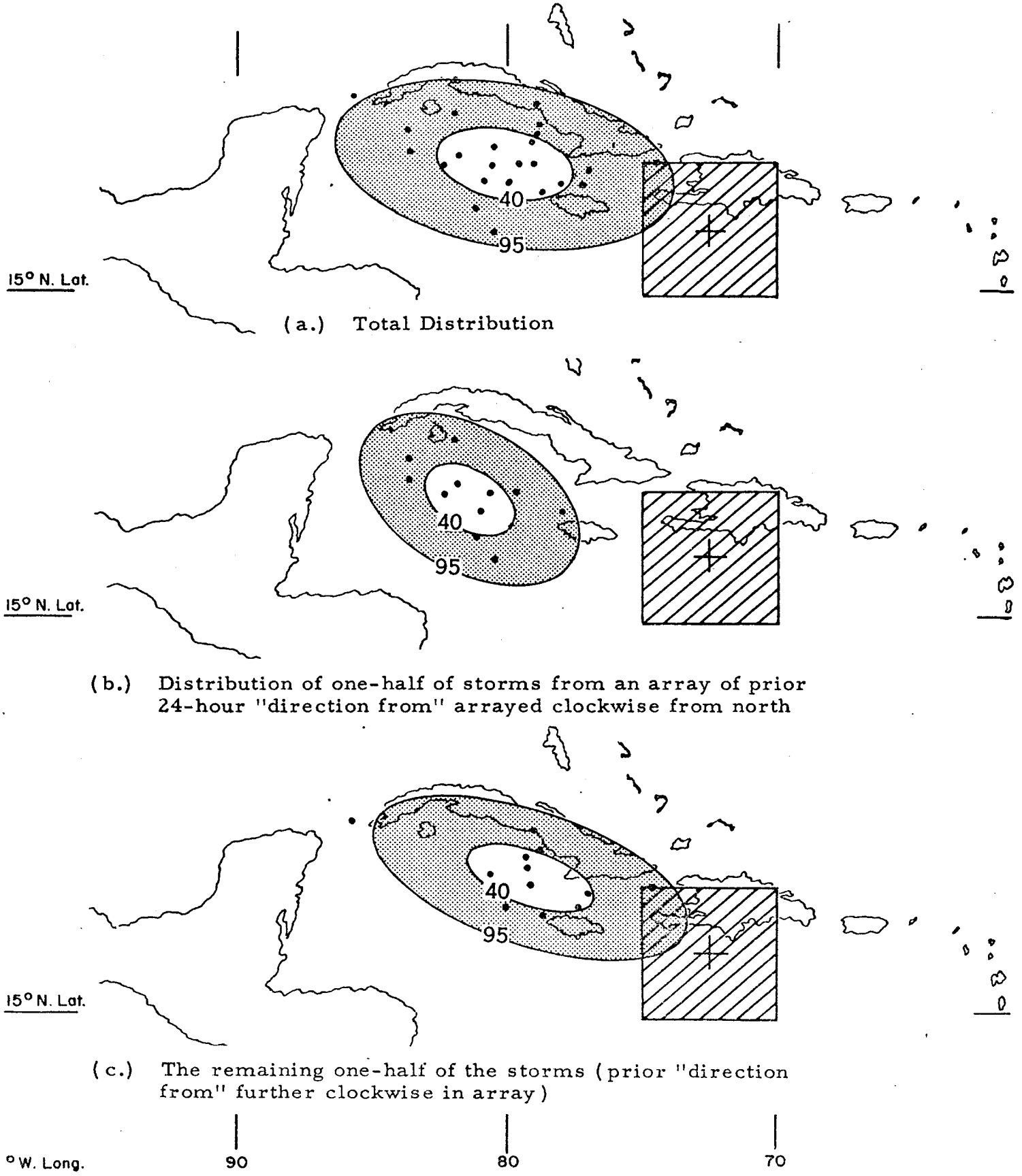


(c.) The remaining one-half of the storms (prior "direction from" further clockwise in array)

Figure 2. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".

HURRICANE POSITION PROBABILITIES FROM CLIMATOLOGICAL DATA

SQUARE 3



(a.) Total Distribution

(b.) Distribution of one-half of storms from an array of prior 24-hour "direction from" arrayed clockwise from north

(c.) The remaining one-half of the storms (prior "direction from" further clockwise in array)

Figure 3. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".

HURRICANE POSITION PROBABILITIES FROM CLIMATOLOGICAL DATA

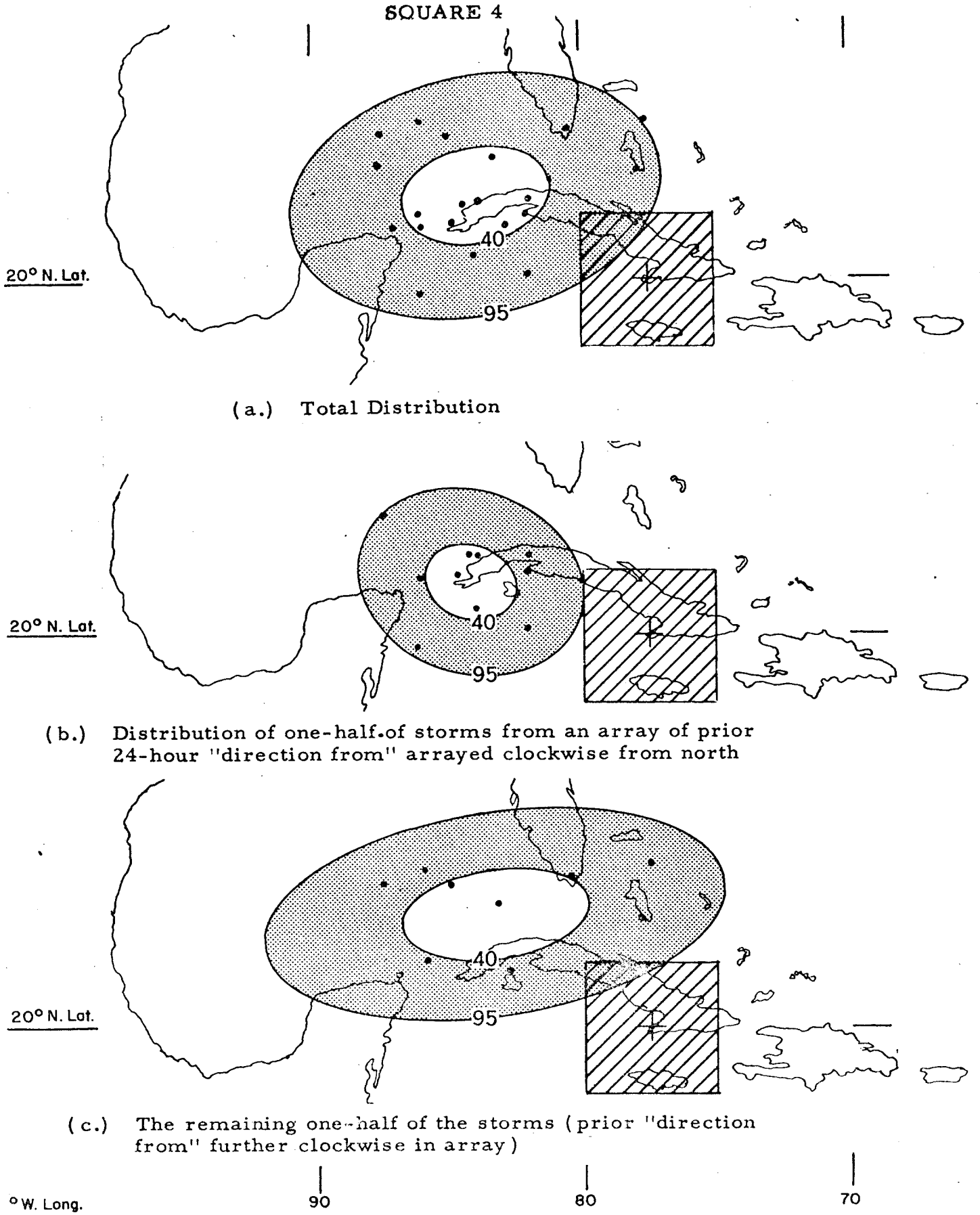


Figure 4. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".

HURRICANE POSITION PROBABILITIES FROM CLIMATOLOGICAL DATA
SQUARE 5

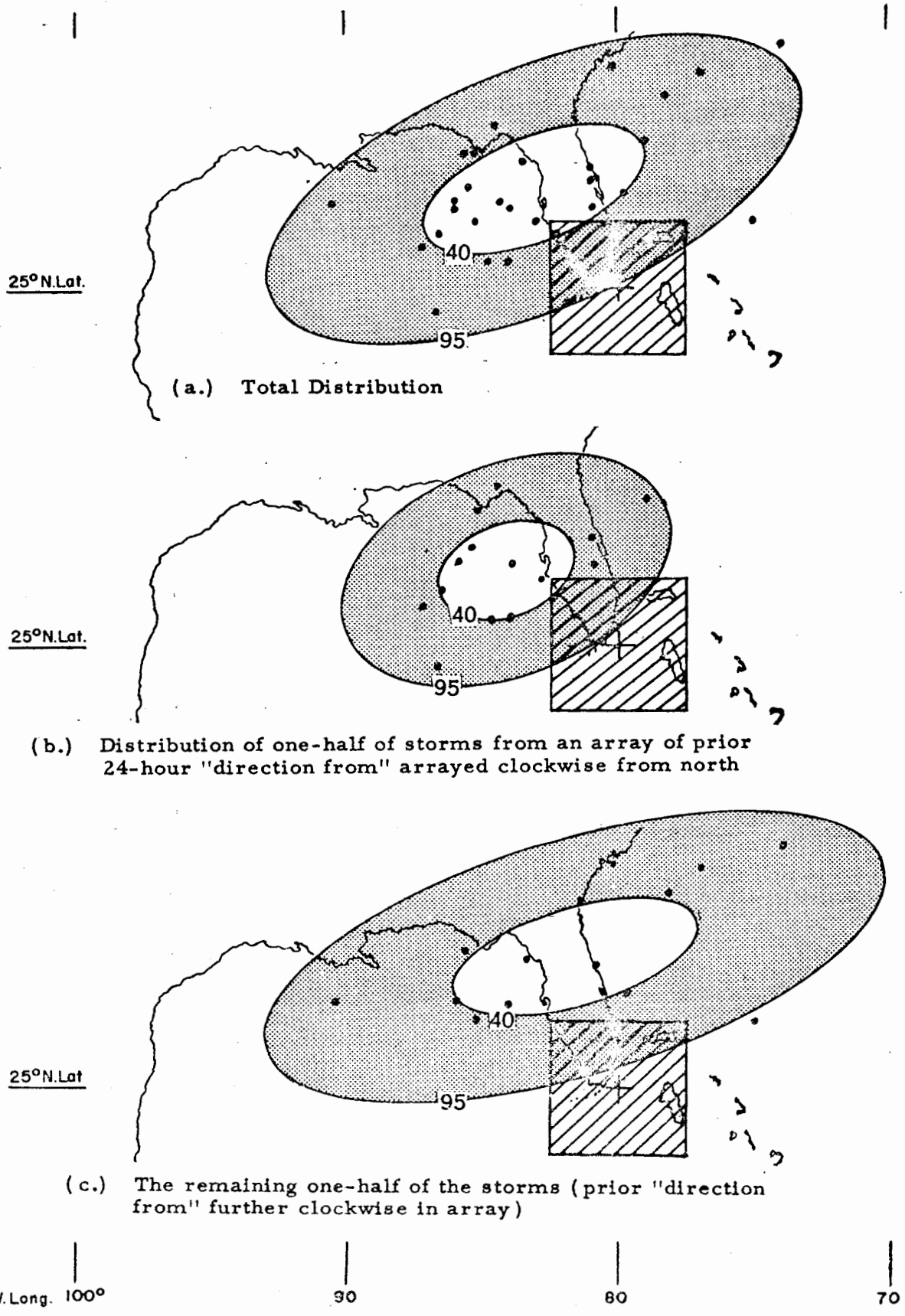


Figure 5. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".

HURRICANE POSITION PROBABILITIES FROM CLIMATOLOGICAL DATA

SQUARE 6

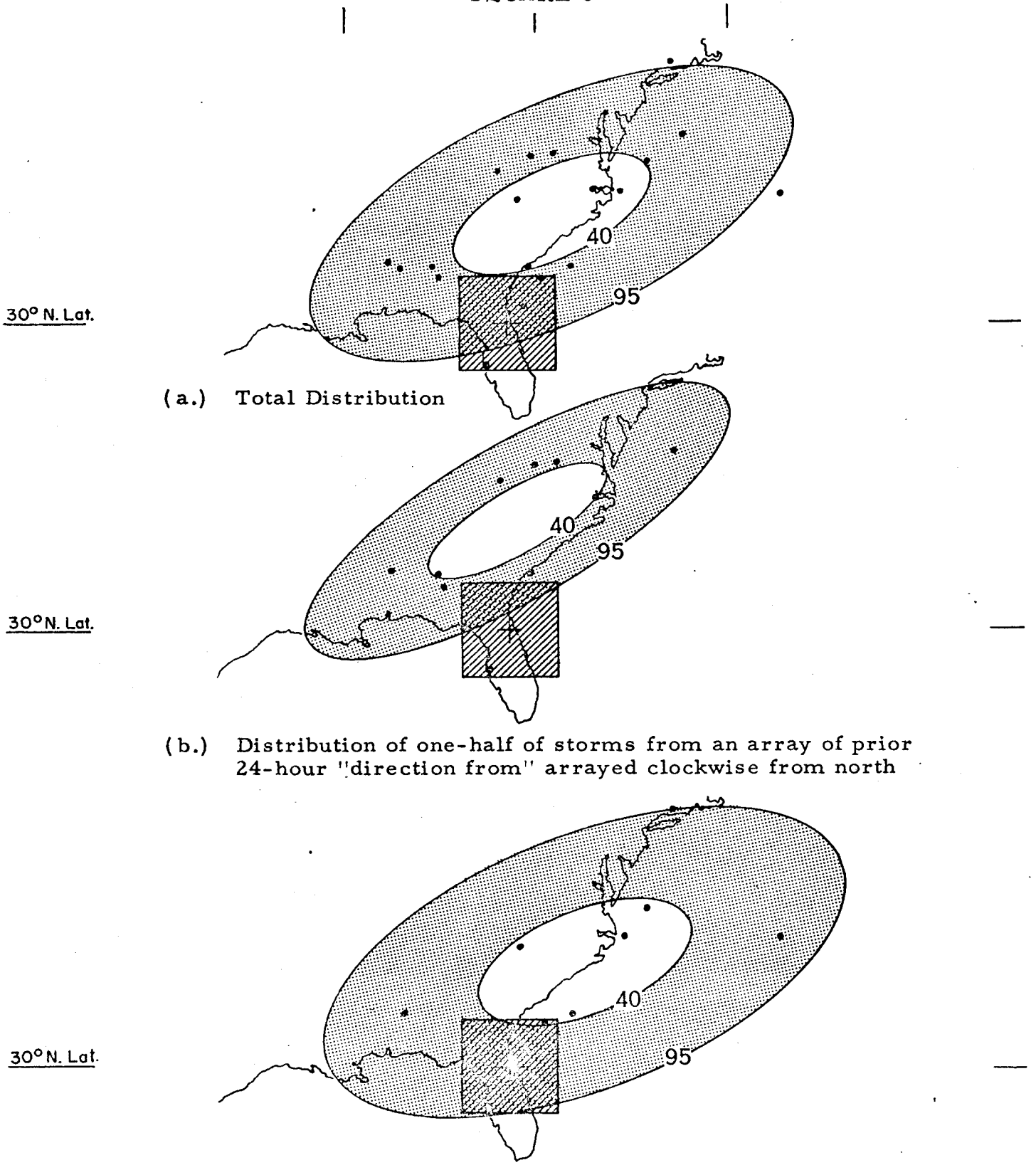
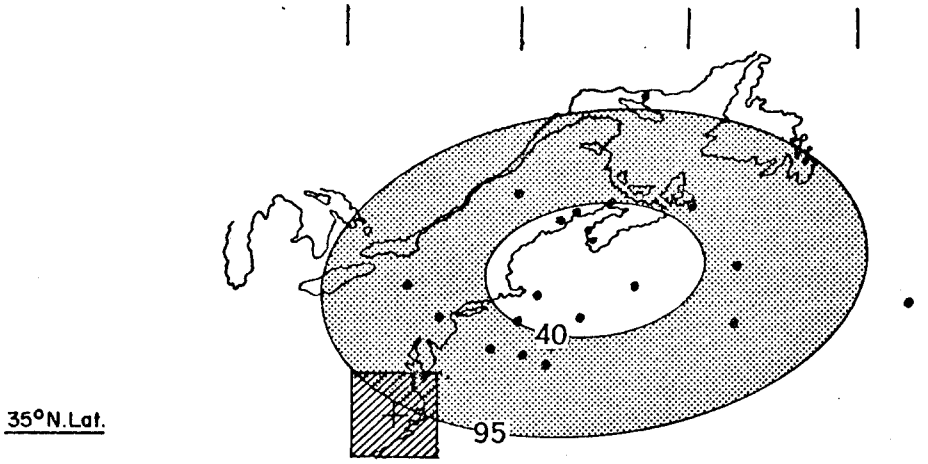


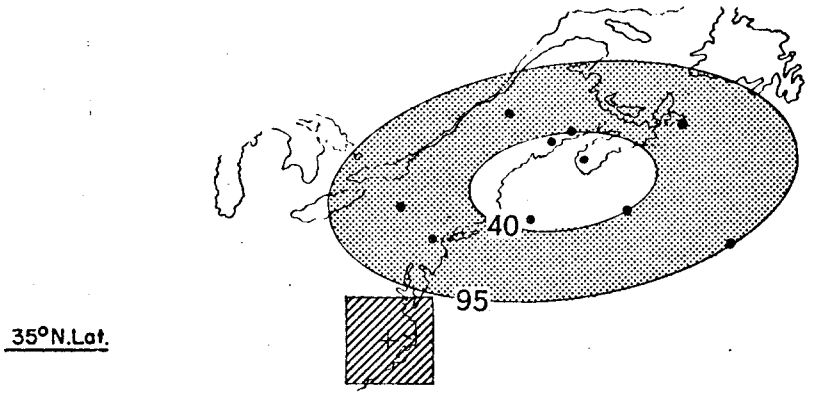
Figure 6. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".

HURRICANE POSITION PROBABILITIES FROM CLIMATOLOGICAL DATA

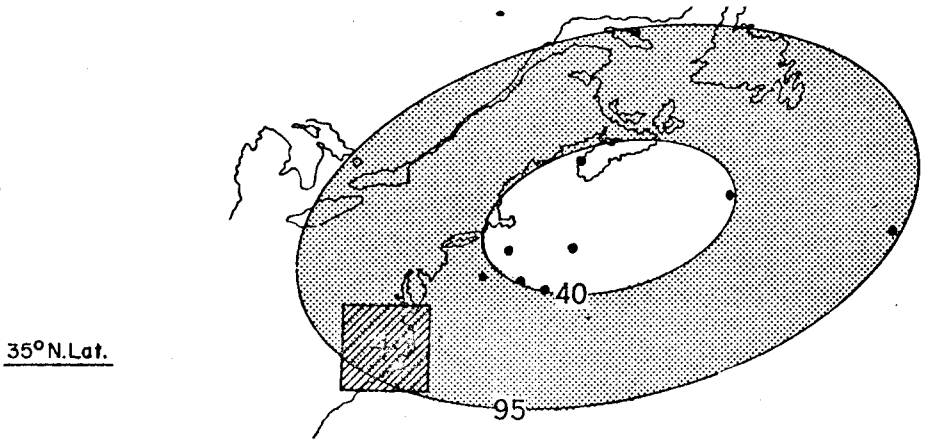
SQUARE 7



(a.) Total Distribution



(b.) Distribution of one-half of storms from an array of prior 24-hour "direction from" arrayed clockwise from north



(c.) The remaining one-half of the storms (prior "direction from" further clockwise in array)

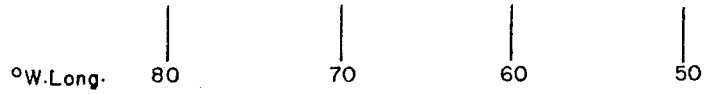
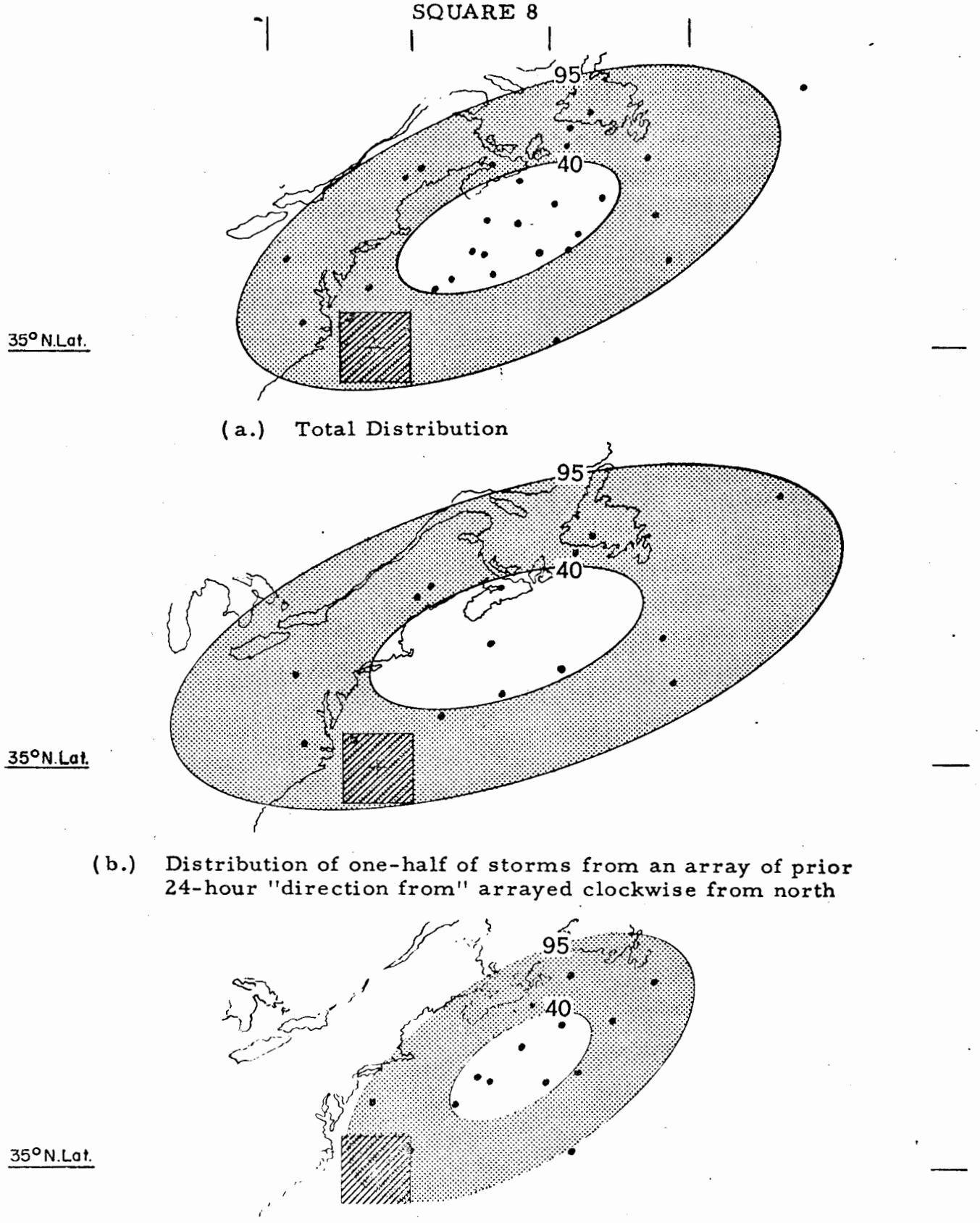


Figure 7. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".



(a.) Total Distribution

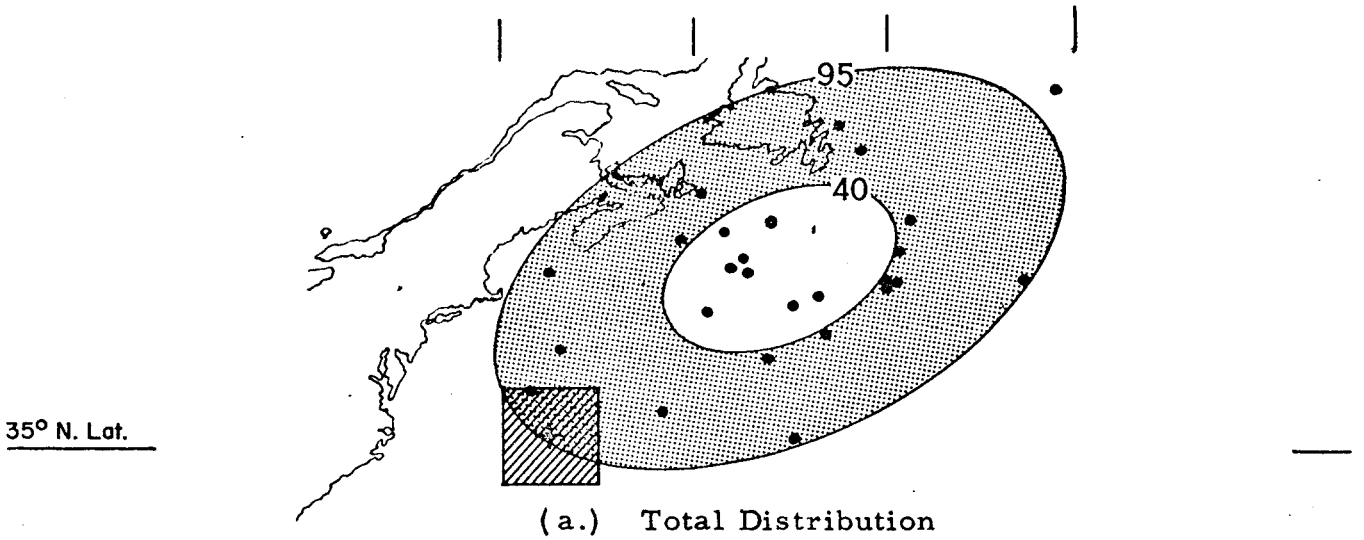
(b.) Distribution of one-half of storms from an array of prior 24-hour "direction from" arrayed clockwise from north

(c.) The remaining one-half of the storms (prior "direction from" further clockwise in array)

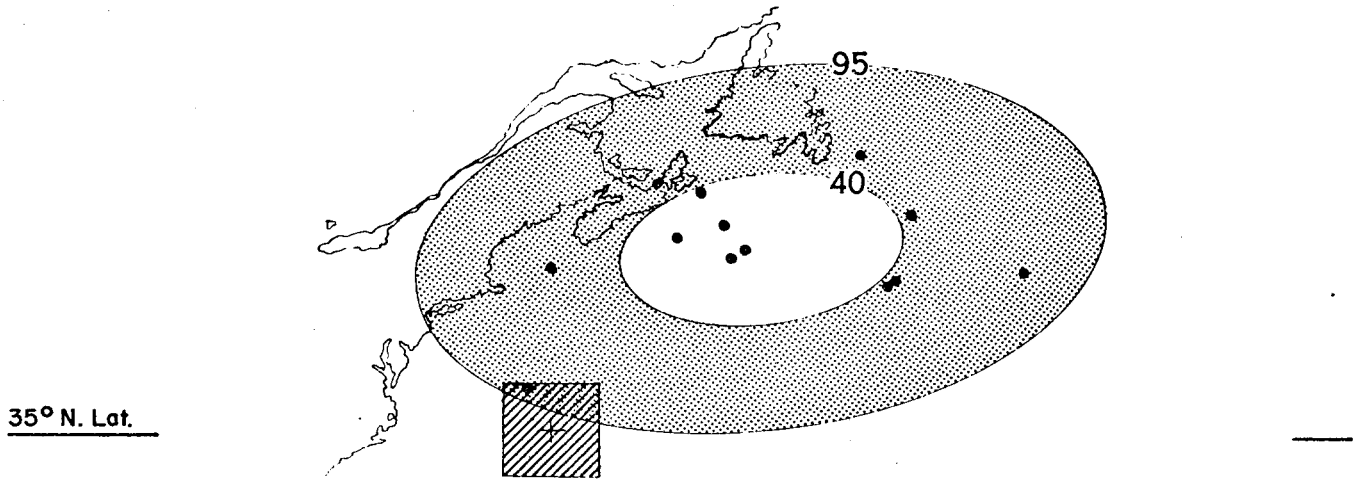
Figure 8. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".

HURRICANE POSITION PROBABILITIES FROM CLIMATOLOGICAL DATA

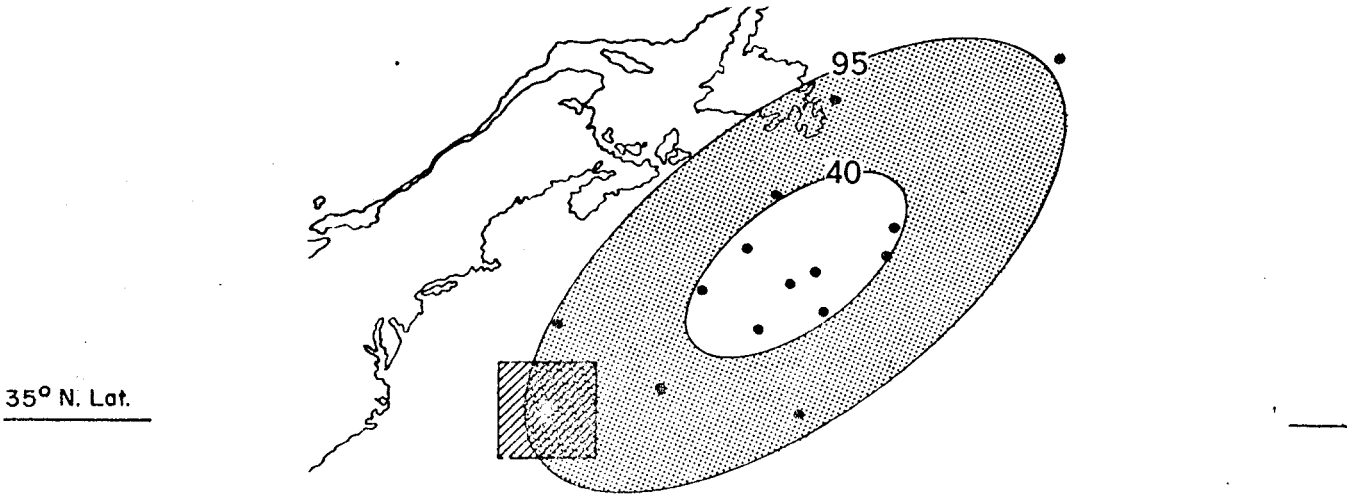
SQUARE 9



(a.) Total Distribution



(b.) Distribution of one-half of storms from an array of prior 24-hour "direction from" arrayed clockwise from north



(c.) The remaining one-half of the storms (prior "direction from" further clockwise in array)

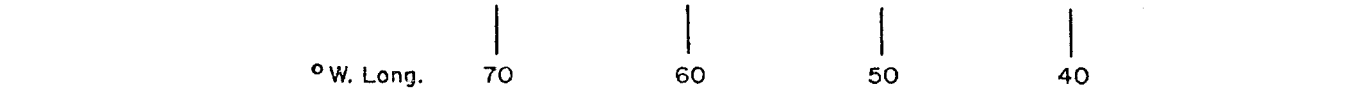


Figure 9. Probability Ellipses of position of tropical storms (1886-1963) which passed through 5-degree area centered on an August 1964 position of "Cleo".

0.40 and 0.95 Probability Ellipses of 36-hour Tropical Storm Movements from the Center of Five-Degree Latitude and Longitude "Squares". Direction Isolines (Bold Lines) are in Degrees Clockwise from North for 24 Hours Prior to 7 A.M. EST Position Nearest Square Through Which Storms Passed. The Five-Degree Squares are Centered on August, 1964 "Cleo's" Path.

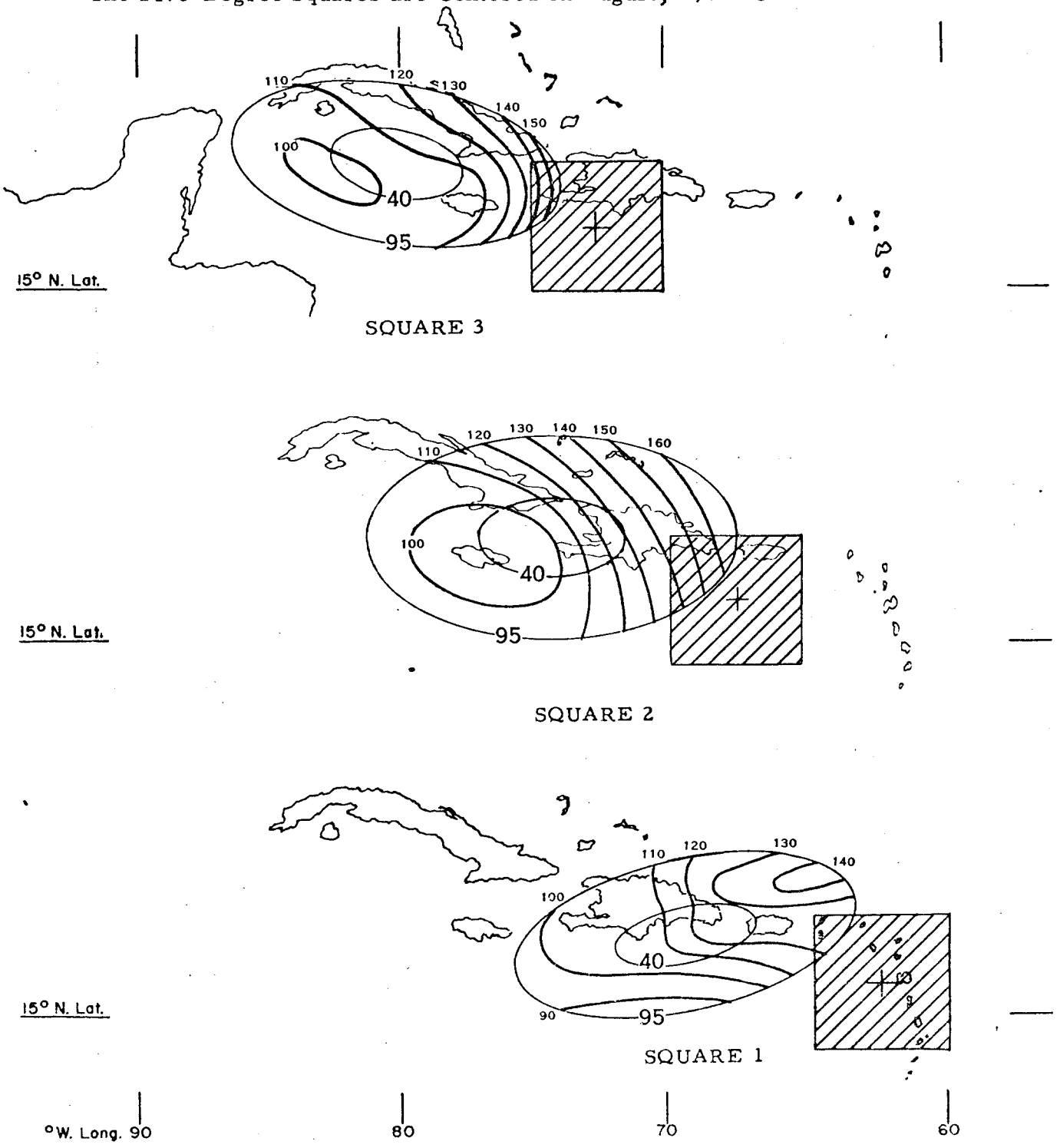


Figure 10. Distribution of tropical storms passing through the eastern and southernmost five-degree "Squares" used in this study centered on "Cleo's" path

0.40 and 0.95 Probability Ellipses of 36-Hour Tropical Storm Movements from the Center of Five-Degree Latitude and Longitude "Squares". Direction Isolines (Bold Lines) are in Degrees Clockwise from North for 24 Hours Prior to 7 A.M. EST Position Nearest Square Through Which Storms Passed. The Five-Degree Squares are Centered on August, 1964 "Cleo's" Path.

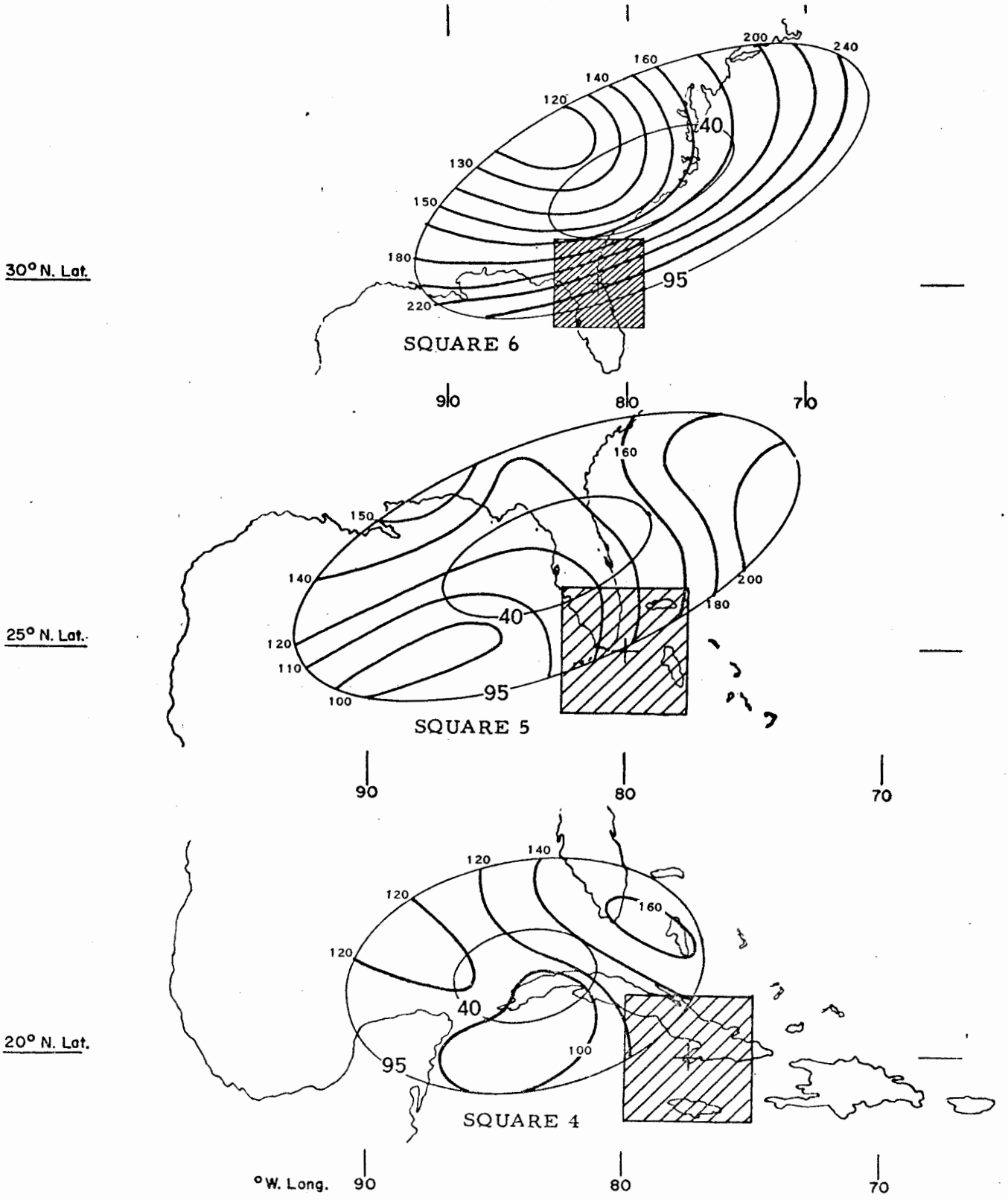


Figure 11. Distribution of tropical storms passing through the westernmost five-degree squares centered on "Cleo's" path

0.40 and 0.95 Probability Ellipses of 36-Hour Tropical Storm Movements from the Center of Five-Degree Latitude and Longitude "Squares". Direction Isolines (Bold Lines) are in Degrees Clockwise from North for 24 Hours Prior to 7 A.M. EST Position Nearest Square Through Which Storms Passed. The Five-Degree Squares are Centered on August, 1964 "Cleo's" Path.

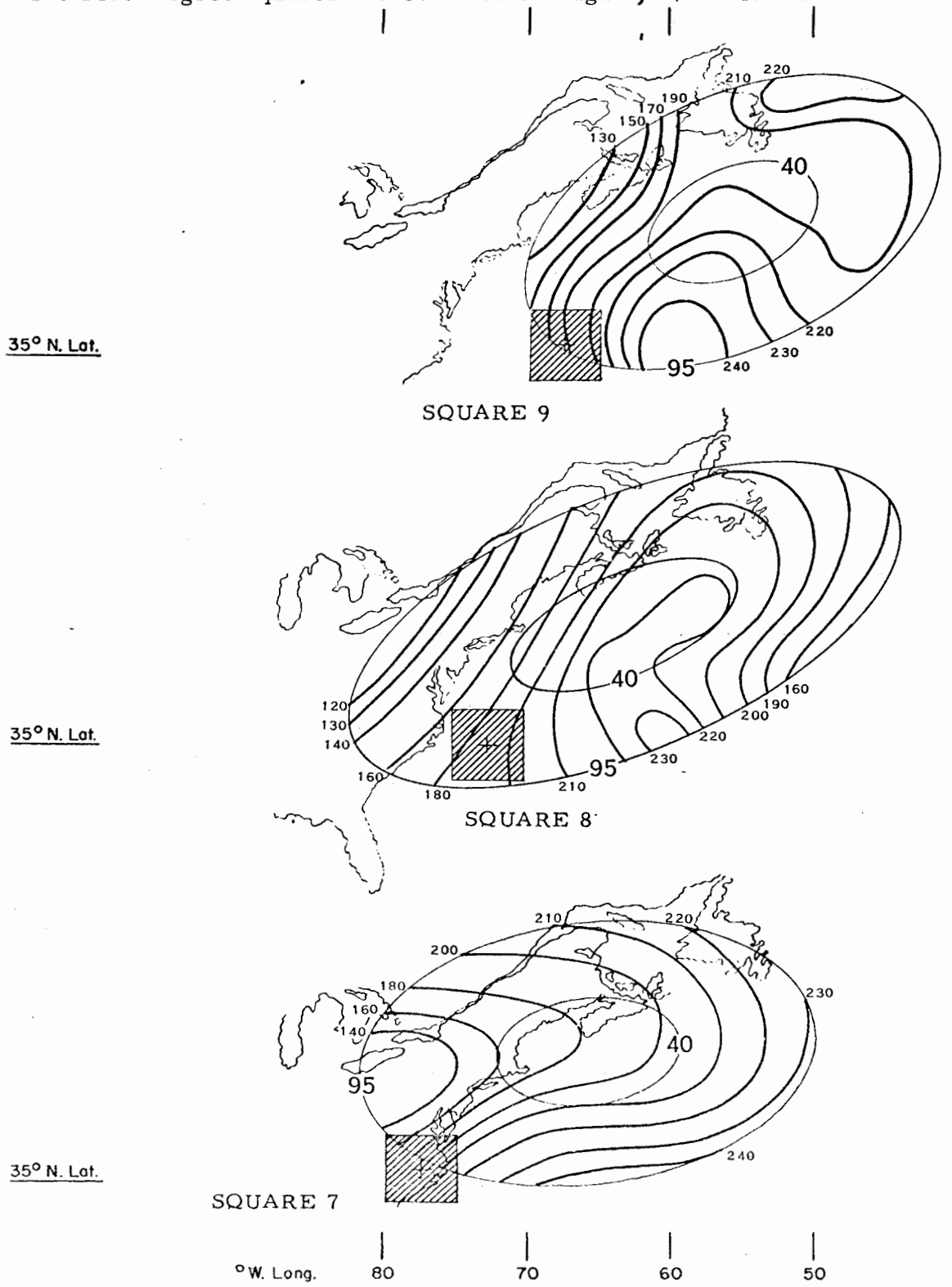


Figure 12. Distribution of tropical storms passing through the most northern and eastern five-degree squares used in this study centered in "Cleo"s" path

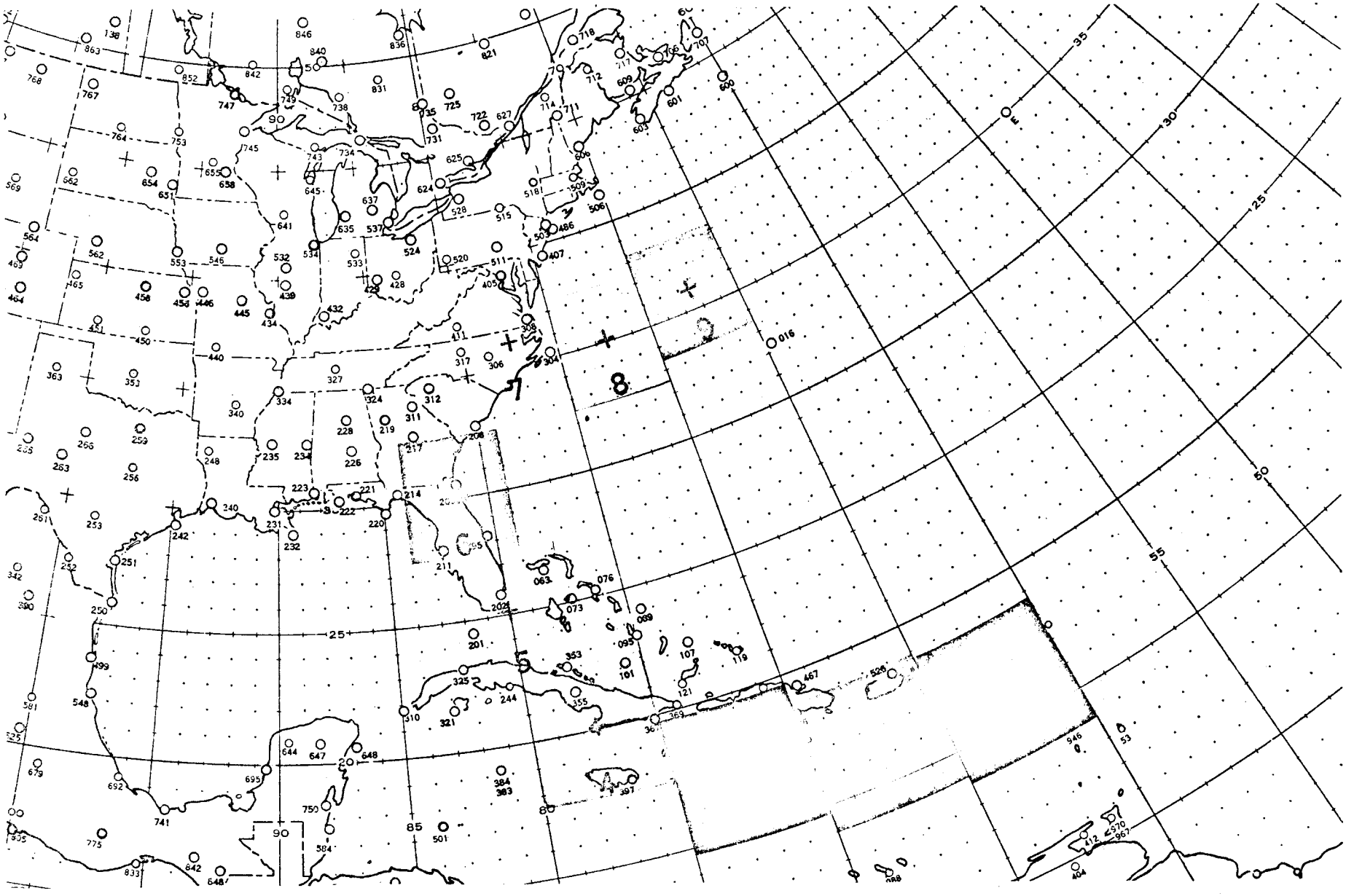


FIGURE 13. SHOWN ARE FIVE-DEGREE SQUARES CENTERED ON THE PATH OF HURRICANE "CLEO" WHICH OCCURRED IN AUGUST, 1964. STATISTICS HAVE BEEN COMPUTED USING DATA FROM STORMS WHICH PASSED THROUGH THESE SQUARES DURING THE PERIOD 1886-1963.

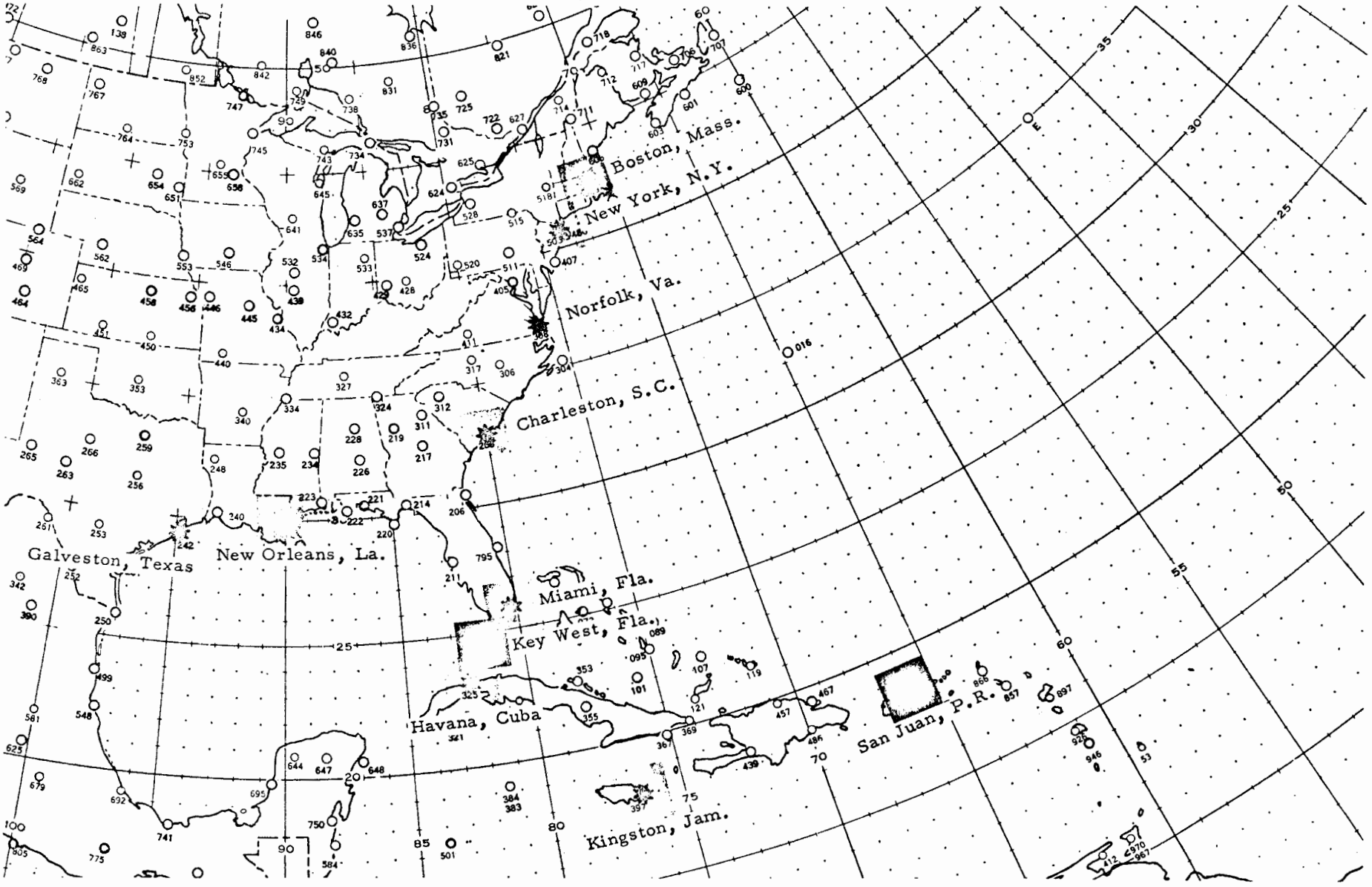


FIGURE 14. SHOWN ARE SELECTED COASTAL CITIES FOR WHICH STORM STRIKE PROBABILITIES HAVE BEEN COMPUTED FROM THE FIVE-DEGREE SQUARE STATISTICS. THE AREA AROUND THE CITIES COVERS ONE DEGREE OF LATITUDE MEASURED FROM THE CENTER OF A CITY PERPENDICULAR TO A SIDE OF THE SQUARE AT THAT CITY'S LATITUDE, AND IS THE AREA OF STRIKE PROBABILITY.

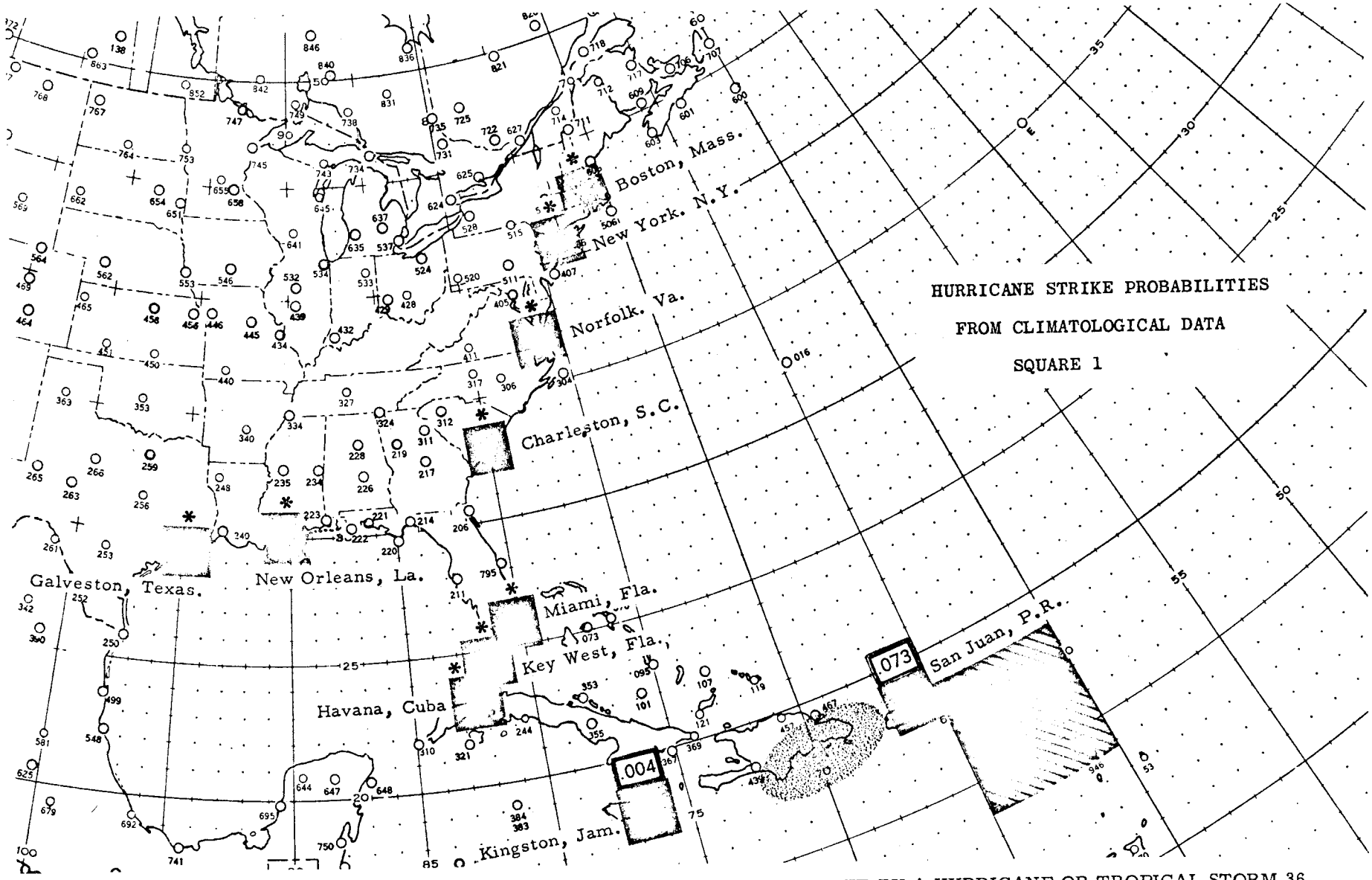


FIGURE 15. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

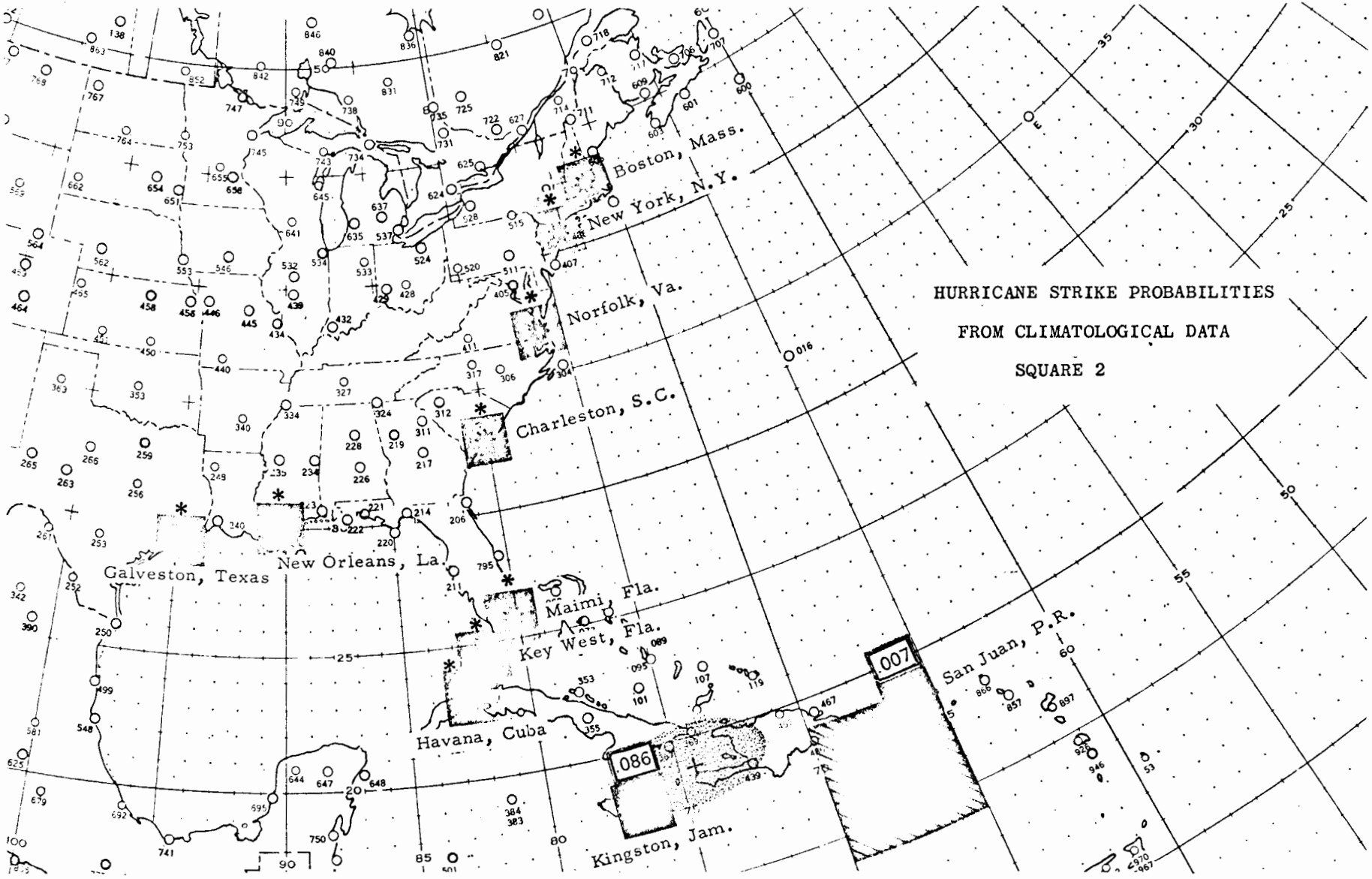


FIGURE 16. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

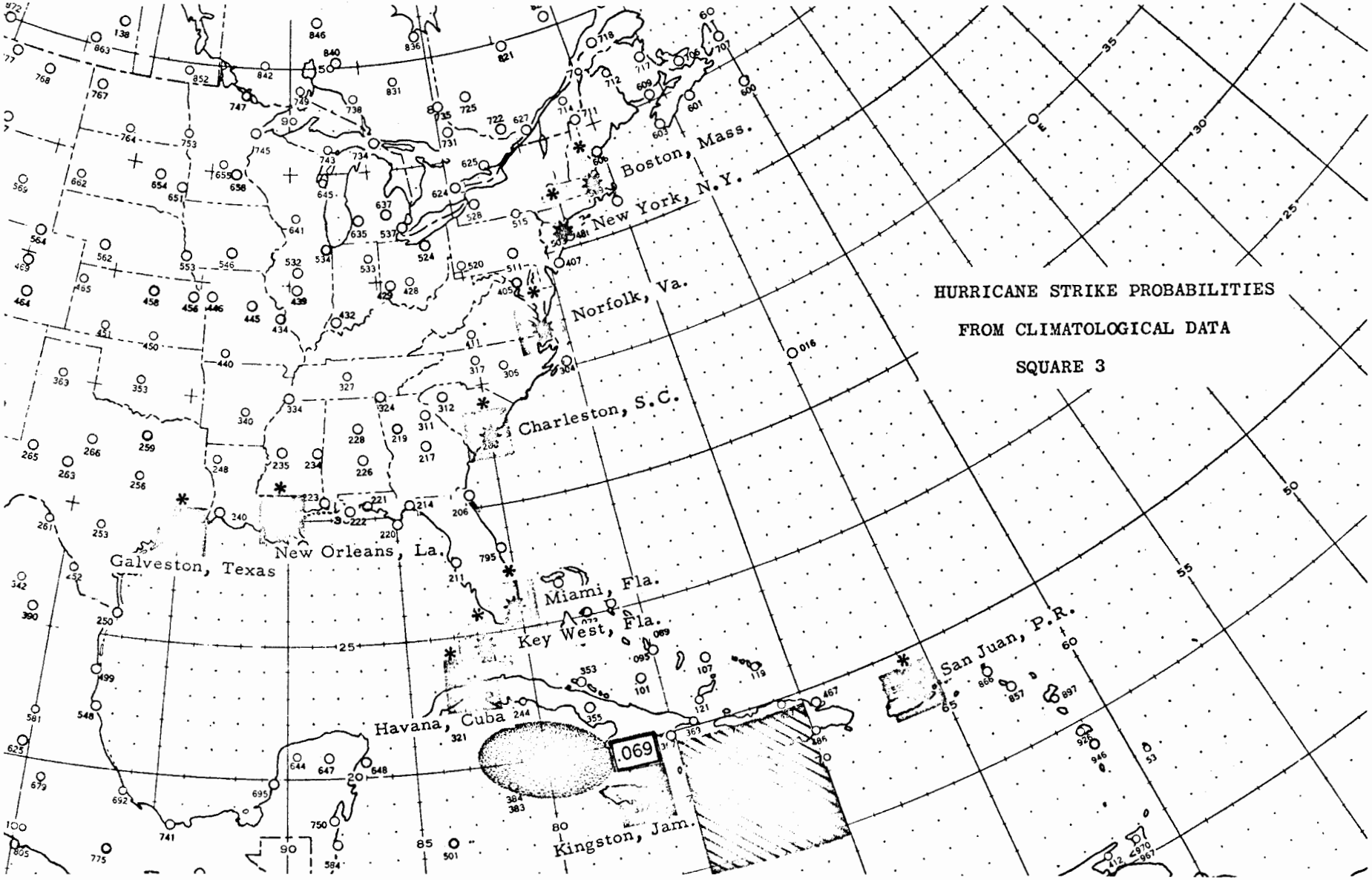


FIGURE 17. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

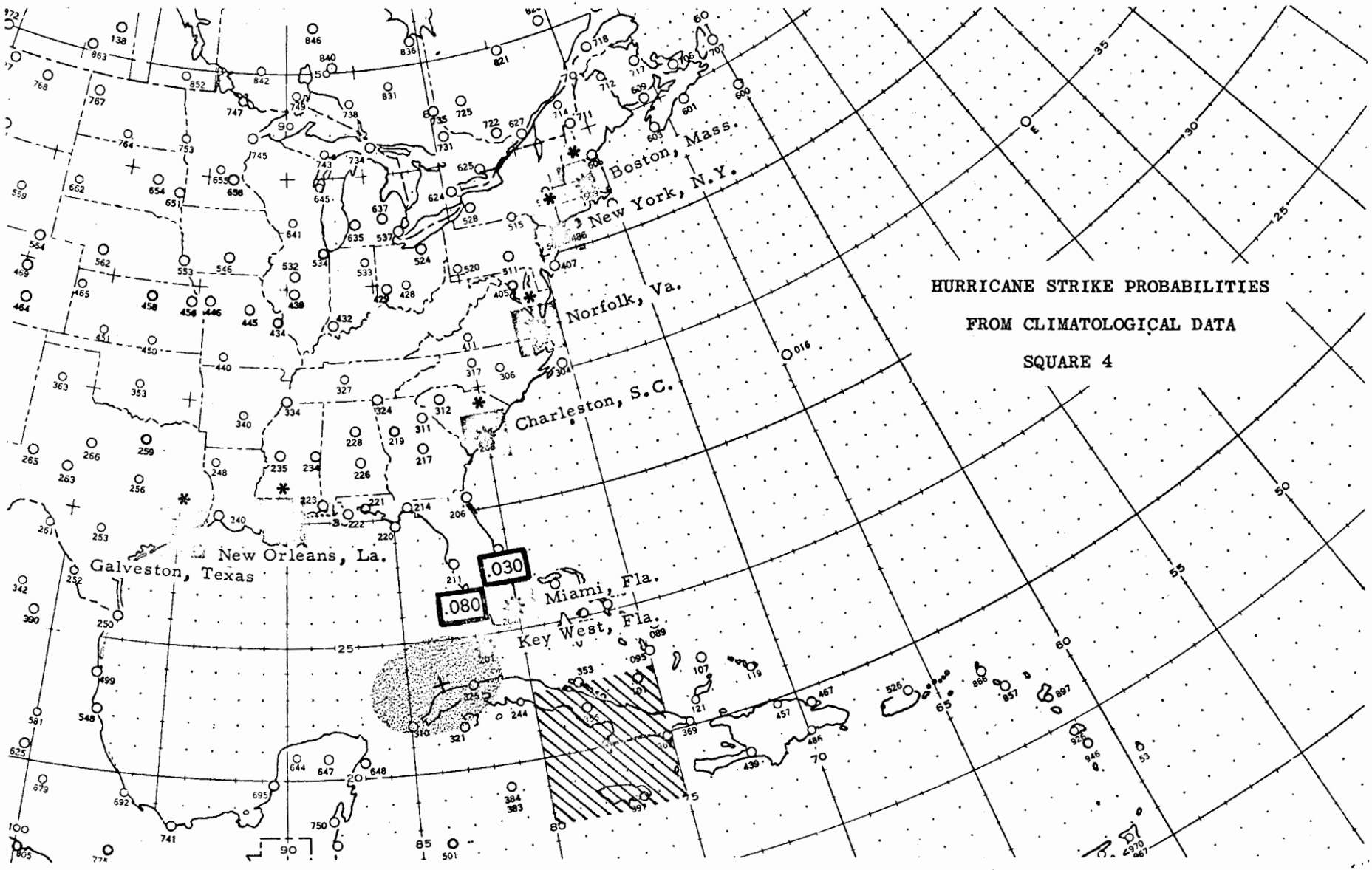


FIGURE 18. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

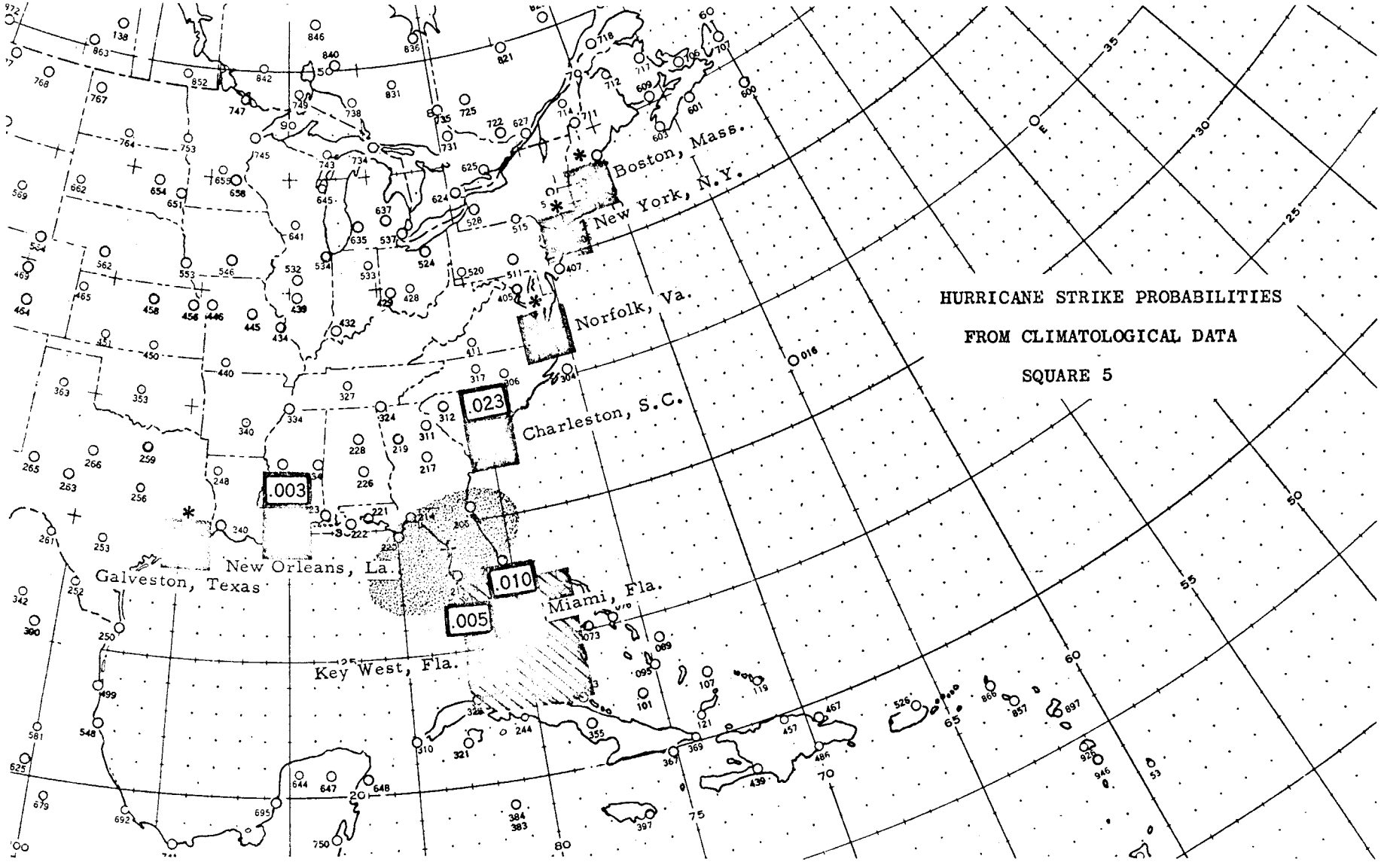


FIGURE 19. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

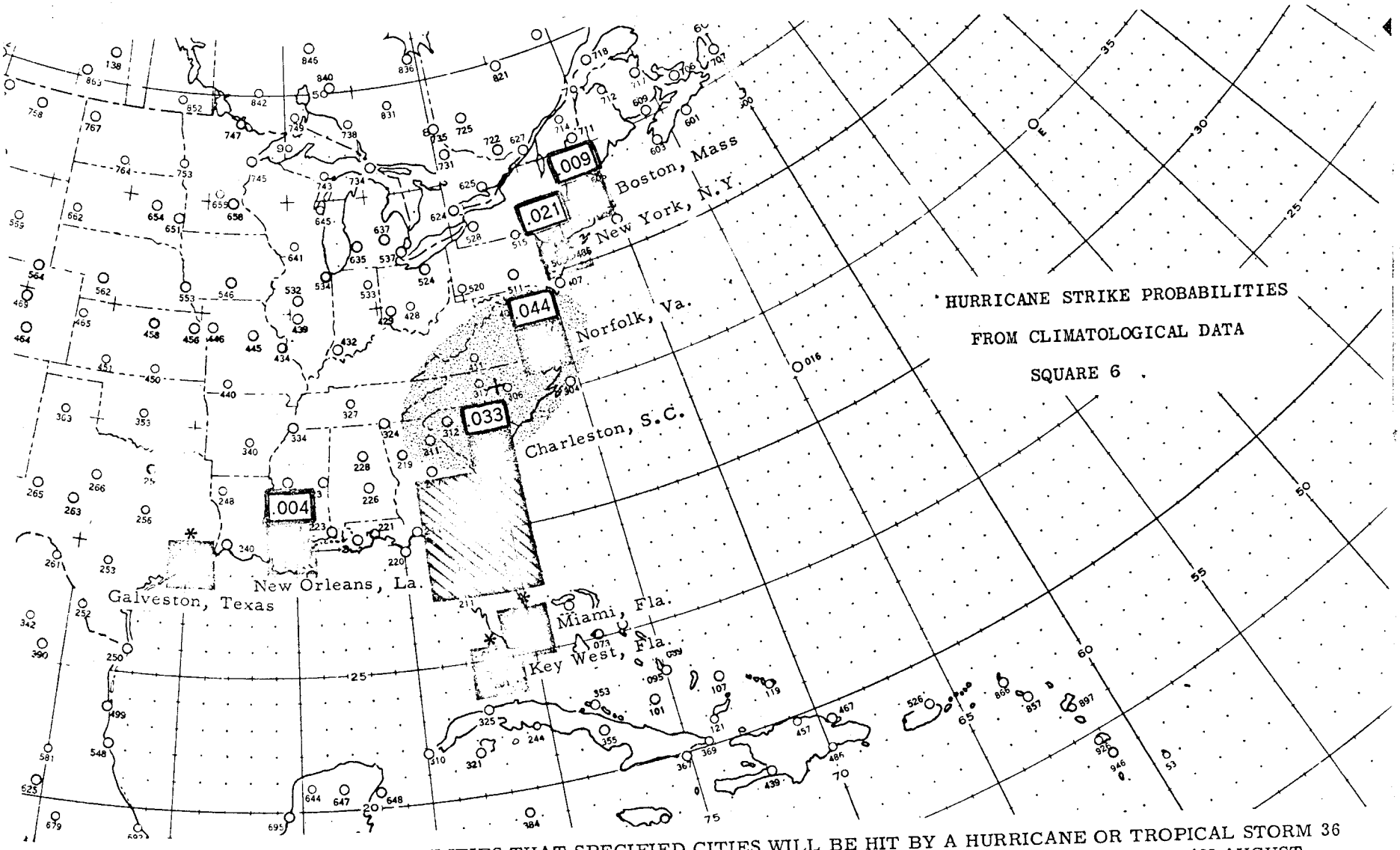


FIGURE 20. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

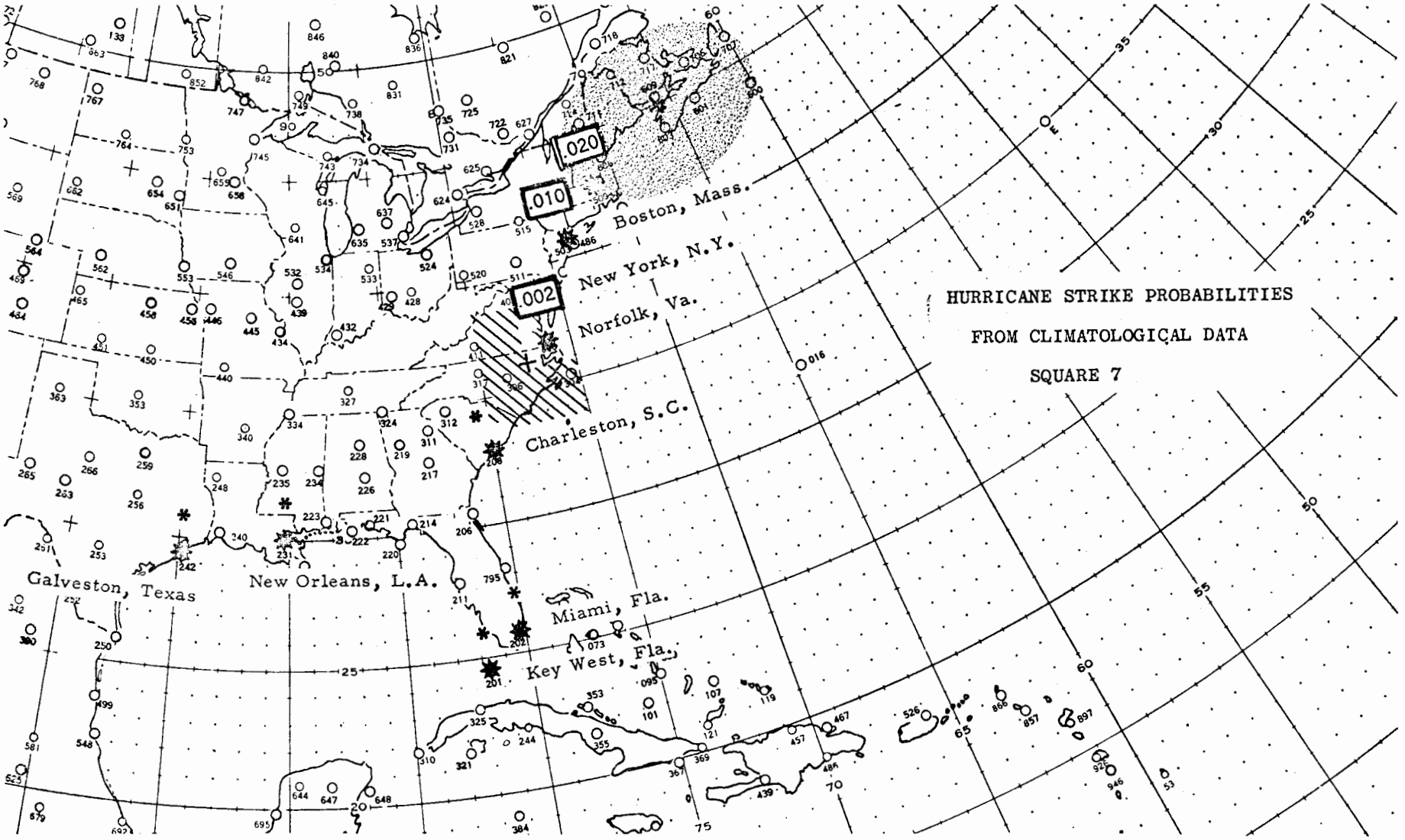


FIGURE 21. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

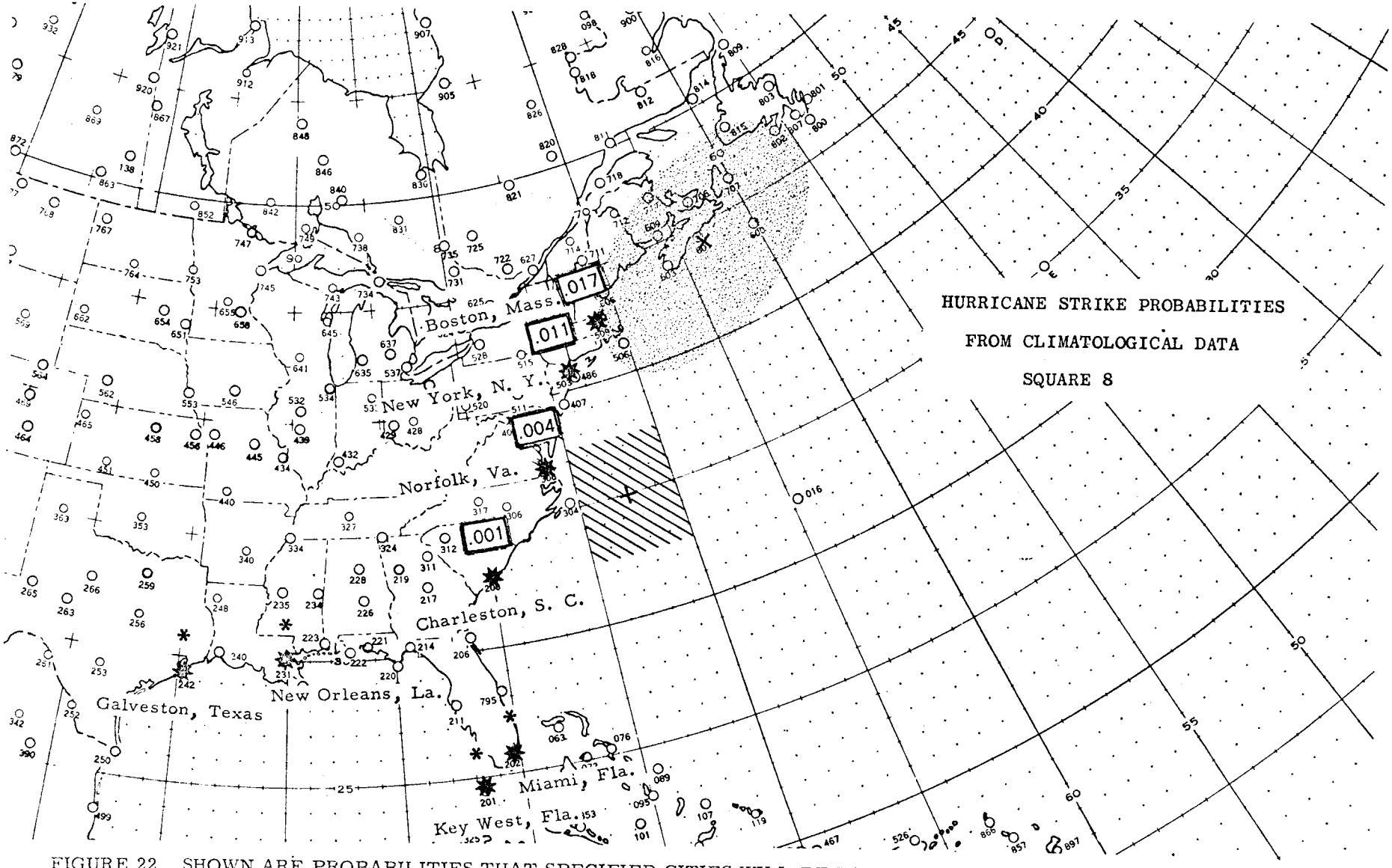


FIGURE 22. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

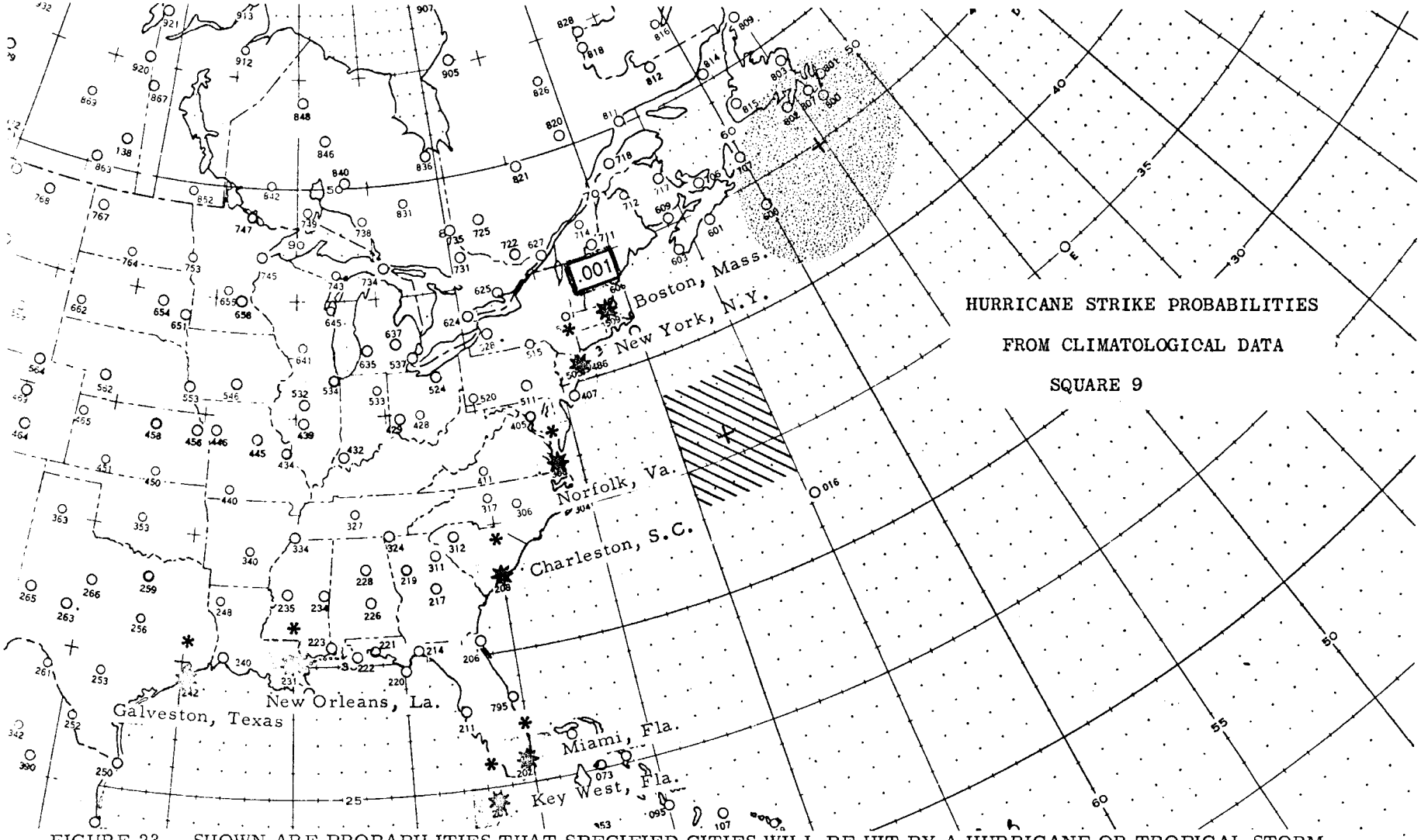


FIGURE 23. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 36 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

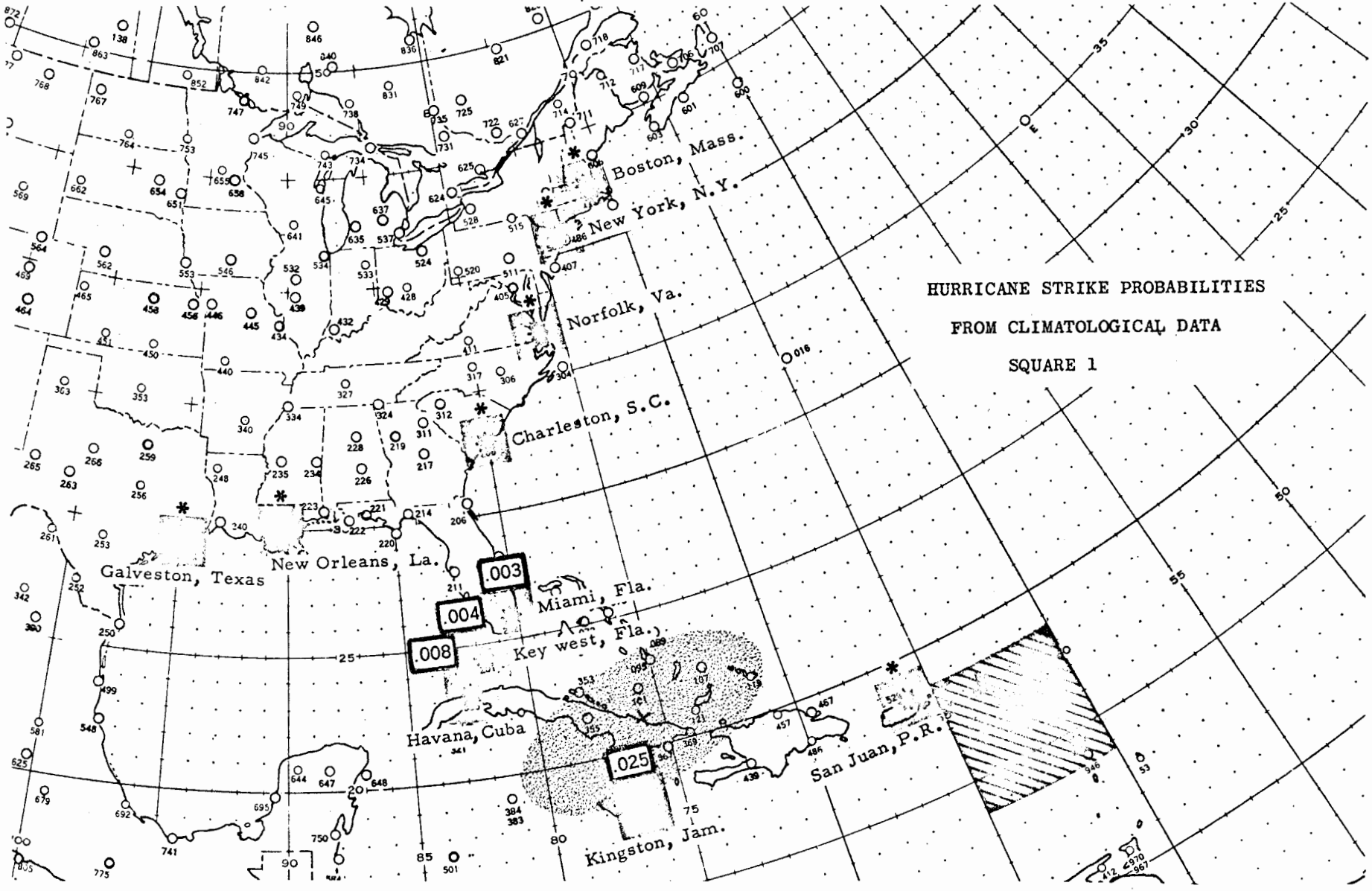


FIGURE 24. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 72 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

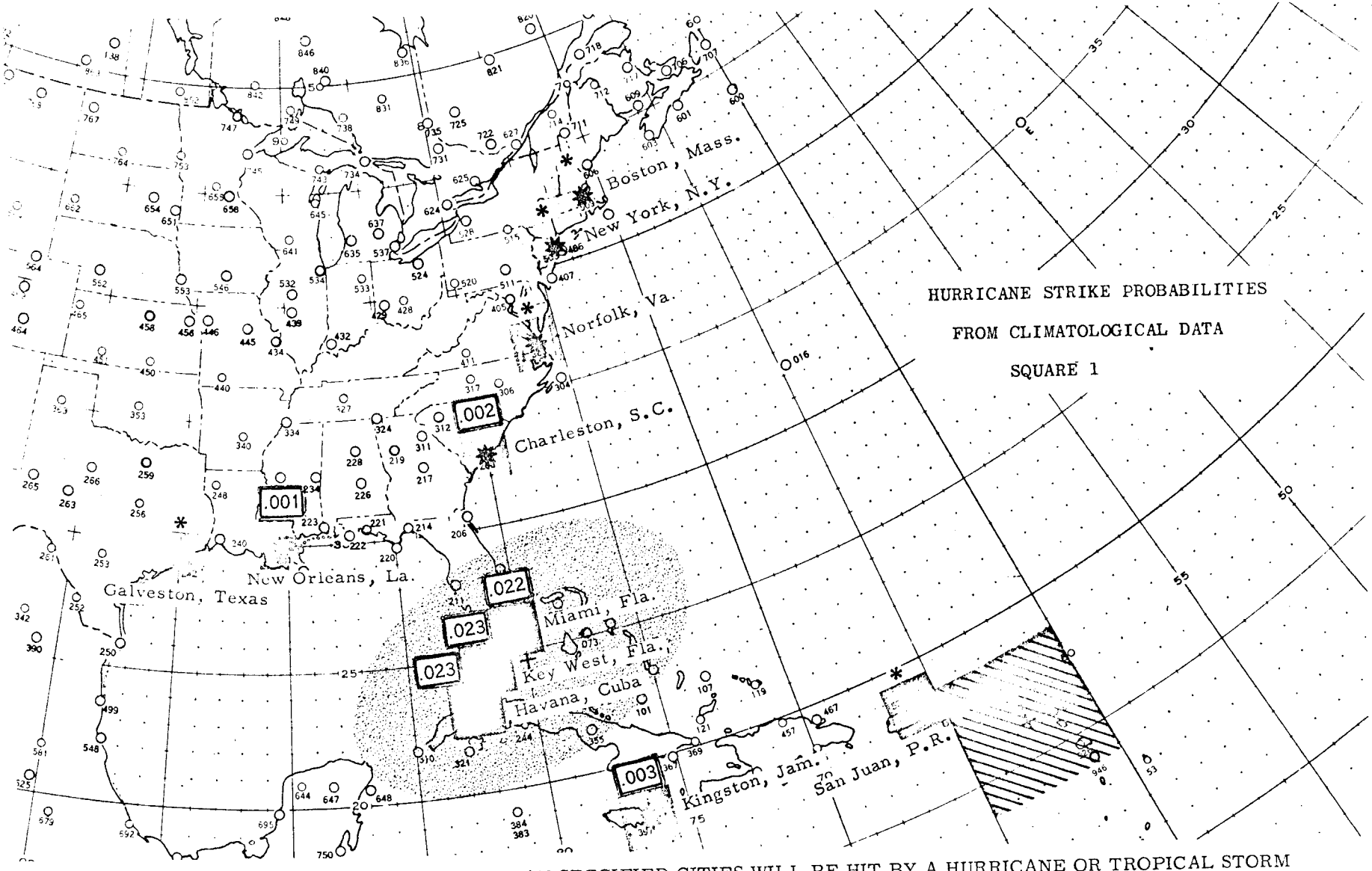


FIGURE 25. SHOWN ARE PROBABILITIES THAT SPECIFIED CITIES WILL BE HIT BY A HURRICANE OR TROPICAL STORM 108 HOURS AFTER THE STORM PASSES THROUGH THE CENTER OF THE FIVE-DEGREE SQUARE CENTERED ON AN AUGUST, 1964, POSITION OF "CLEO". PROBABILITIES MAY BE ADJUSTED SLIGHTLY FOR ANY STORM WHICH PASSES THROUGH THE SQUARE, YET NOT THROUGH THE EXACT CENTER. A 0.40 PROBABILITY ELLIPSE CENTERED ON THE DISTRIBUTION CENTROID IS SHOWN. AN ASTERISK INDICATES A PROBABILITY LESS THAN 0.000. THE PERIOD OF RECORD, 1886-1963, WAS USED TO PRODUCE THESE STATISTICS.

HURRICANE STRIKE PROBABILITIES FROM CLIMATOLOGICAL DATA

OF SPECIFIED COASTAL CITIES

Galveston, Texas

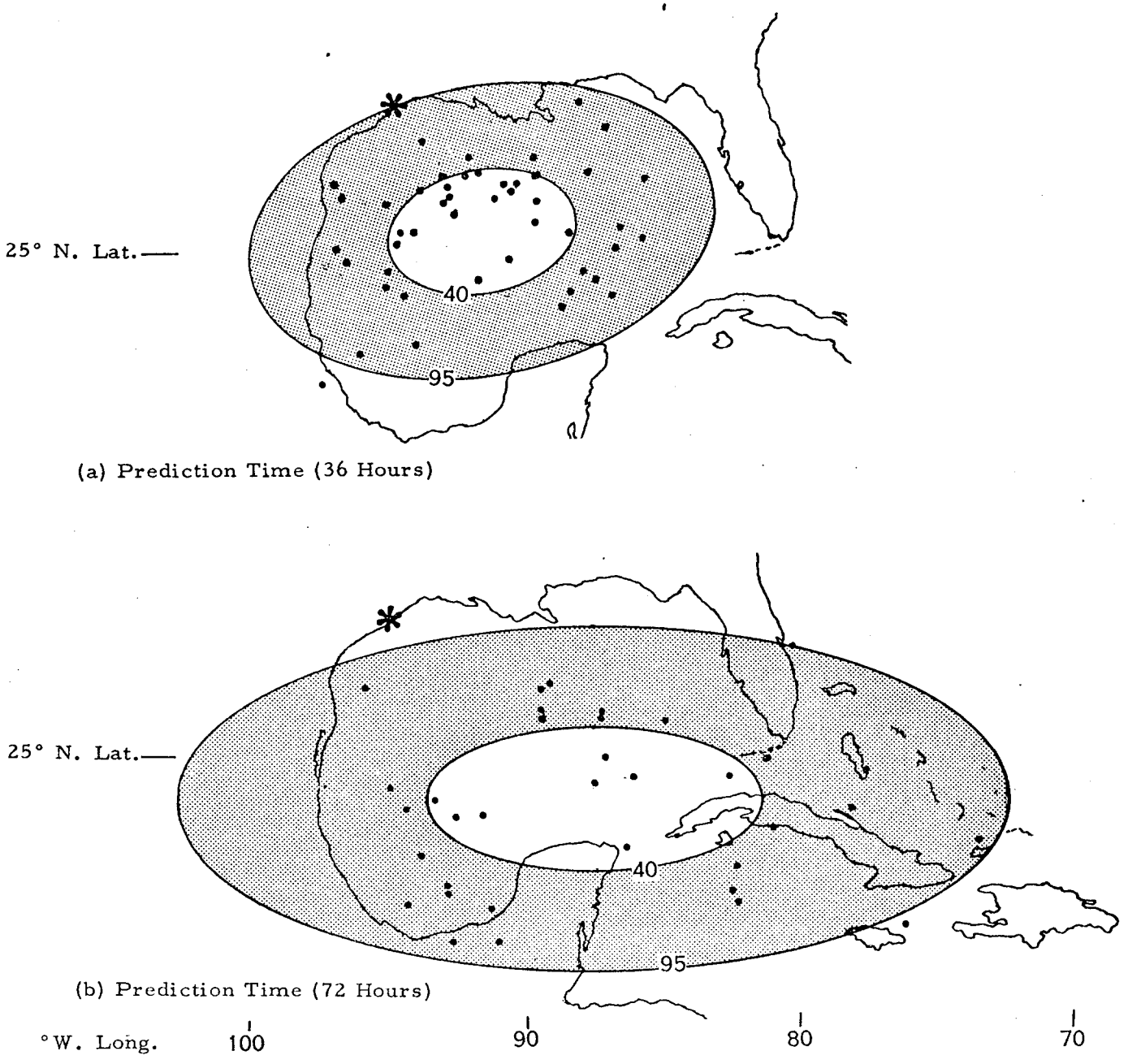


Figure 26. Hurricane and tropical storm strike probabilities in (a) 36 hours and (b) 72 hours at specific coastal cities. The 0.40 and 0.95 probability ellipses are centered on the distribution centroid. This distribution is based on data from storms which did strike or pass within two degrees latitude of the city shown, during the period 1886-1963. The distribution is not dependent on prior storm trajectory. This does not include hurricane and tropical storms within the ellipse area which did not strike the city.

HURRICANE STRIKE PROBABILITIES FROM CLIMATOLOGICAL DATA

OF SPECIFIED COASTAL CITIES

New Orleans, Louisiana

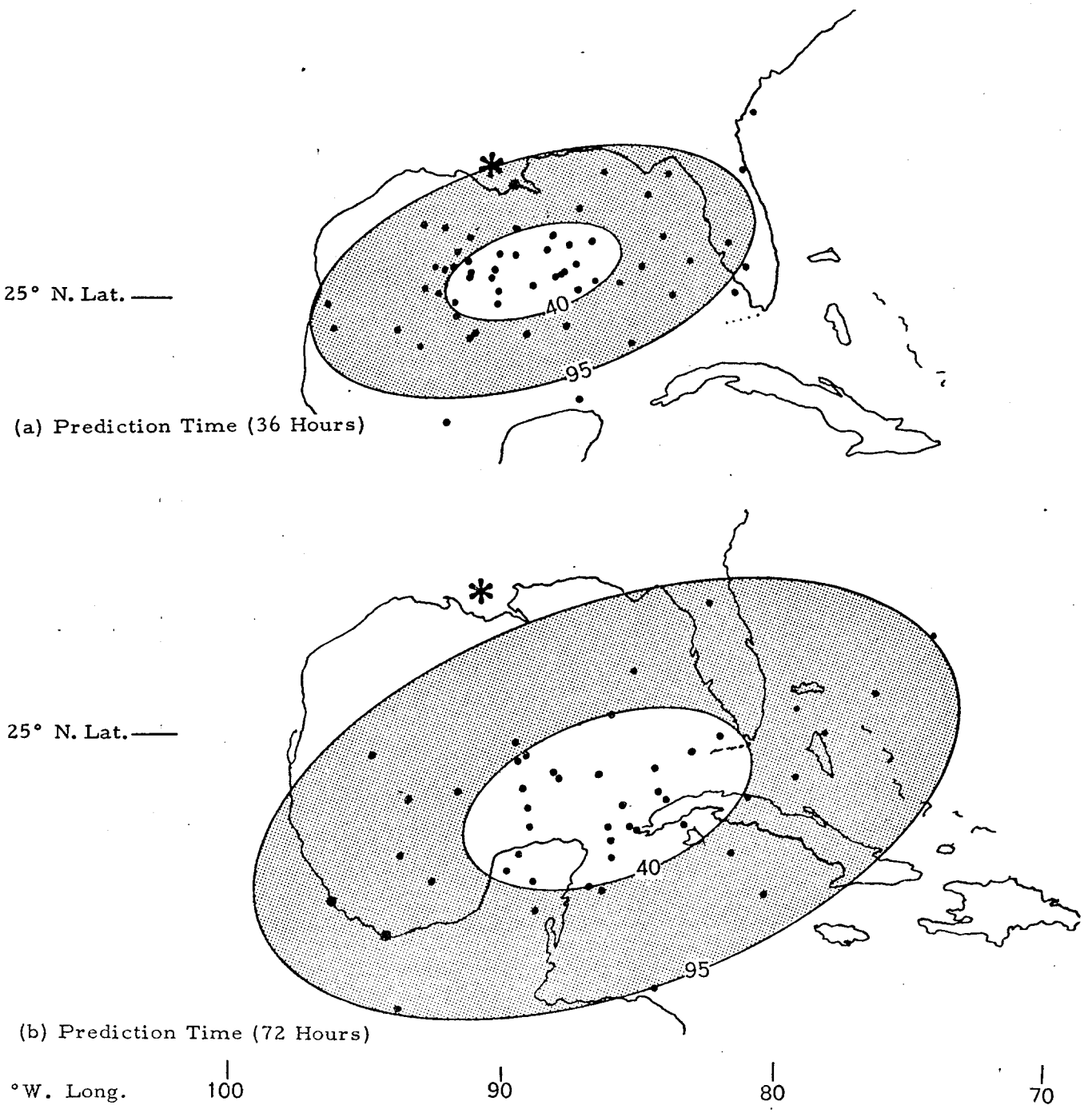


Figure 27. Hurricane and tropical storm strike probabilities in (a) 36 hours and (b) 72 hours at specific coastal cities. The 0.40 and 0.95 probability ellipses are centered on the distribution centroid. This distribution is based on data from storms which did strike or pass within two degrees latitude of the city shown, during the period 1886-1963. The distribution is not dependent on prior storm trajectory. This does not include hurricane and tropical storms within the ellipse area which did not strike the city.

HURRICANE STRIKE PROBABILITIES FROM CLIMATOLOGICAL DATA

OF SPECIFIED COASTAL CITIES

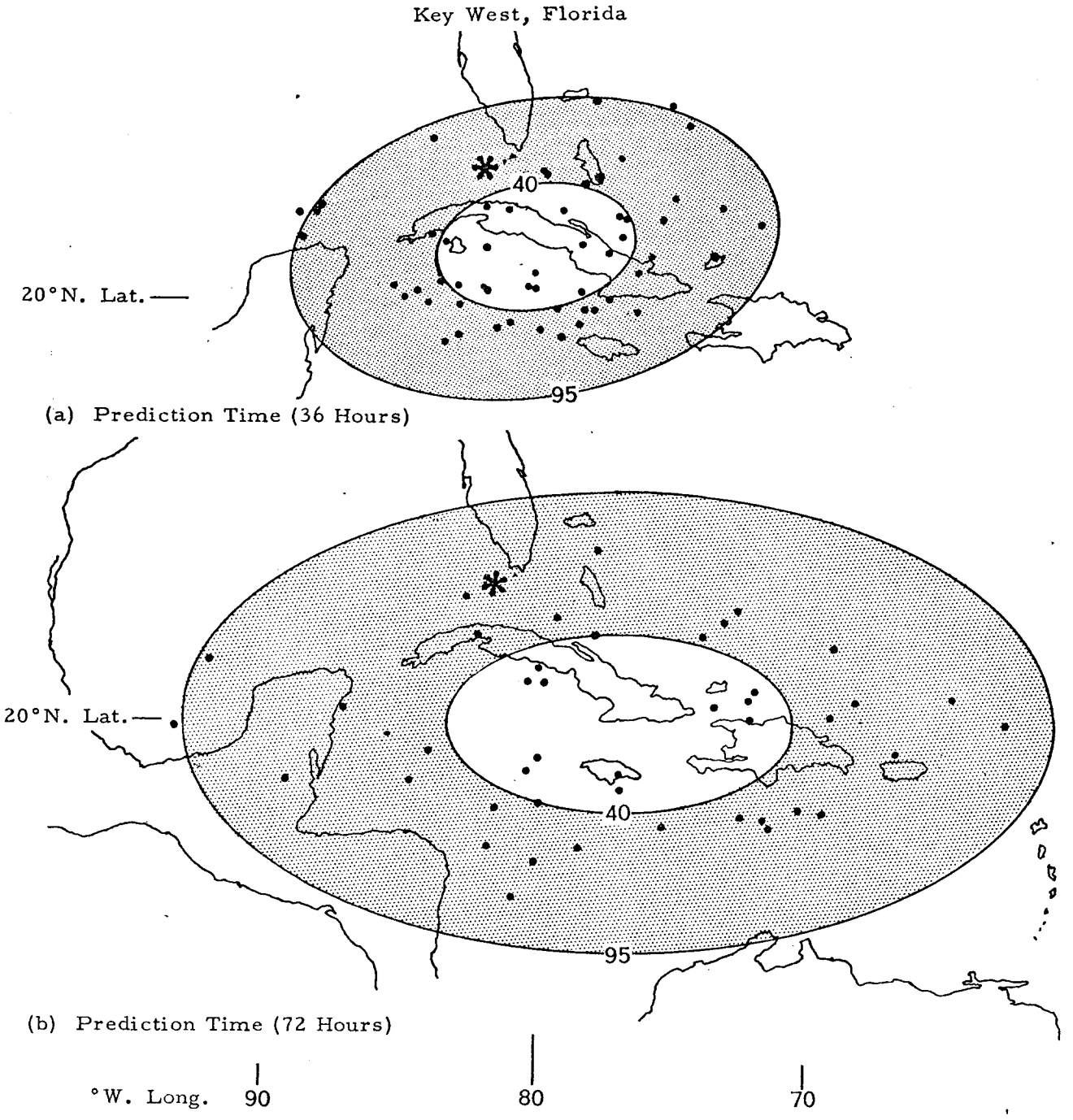


Figure 28. Hurricane and tropical storm strike probabilities in (a) 36 hours and (b) 72 hours at specific coastal cities. The 0.40 and 0.95 probability ellipses are centered on the distribution centroid. This distribution is based on data from storms which did strike or pass within two degrees latitude of the city shown, during the period 1886-1963. The distribution is not dependent on prior storm trajectory. This does not include hurricane and tropical storms within the ellipse area which did not strike the city.

HURRICANE STRIKE PROBABILITIES FROM CLIMATOLOGICAL DATA

OF SPECIFIED COASTAL CITIES

Miami, Florida

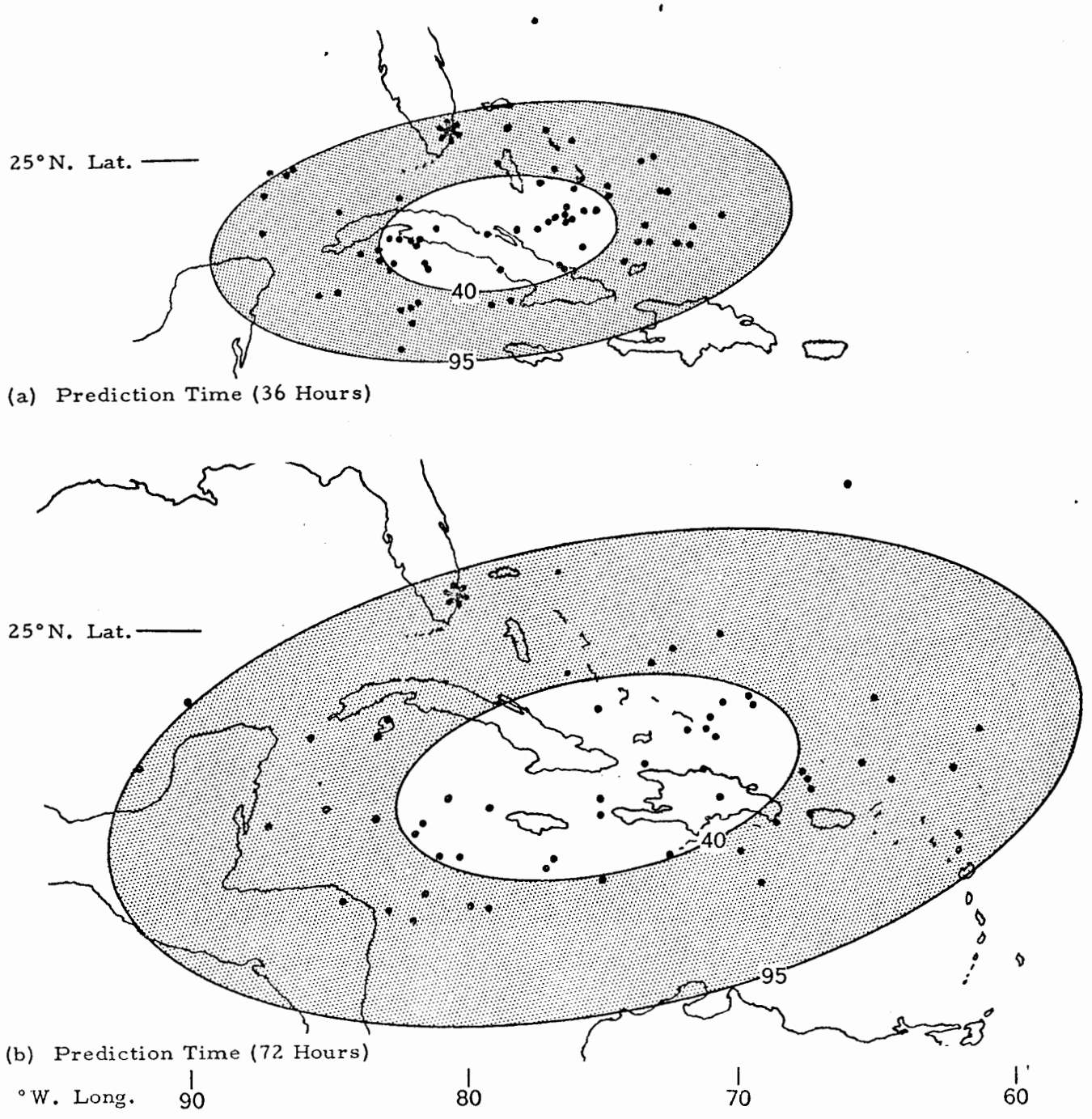


Figure 29. Hurricane and tropical storm strike probabilities in (a) 36 hours and (b) 72 hours at specific coastal cities. The 0.40 and 0.95 probability ellipses are centered on the distribution centroid. This distribution is based on data from storms which did strike or pass within two degrees latitude of the city shown, during the period 1886-1963. The distribution is not dependent on prior storm trajectory. This does not include hurricane and tropical storms within the ellipse area which did not strike the city.

HURRICANE STRIKE PROBABILITIES FROM CLIMATOLOGICAL DATA

OF SPECIFIED COASTAL CITIES

Charleston, South Carolina

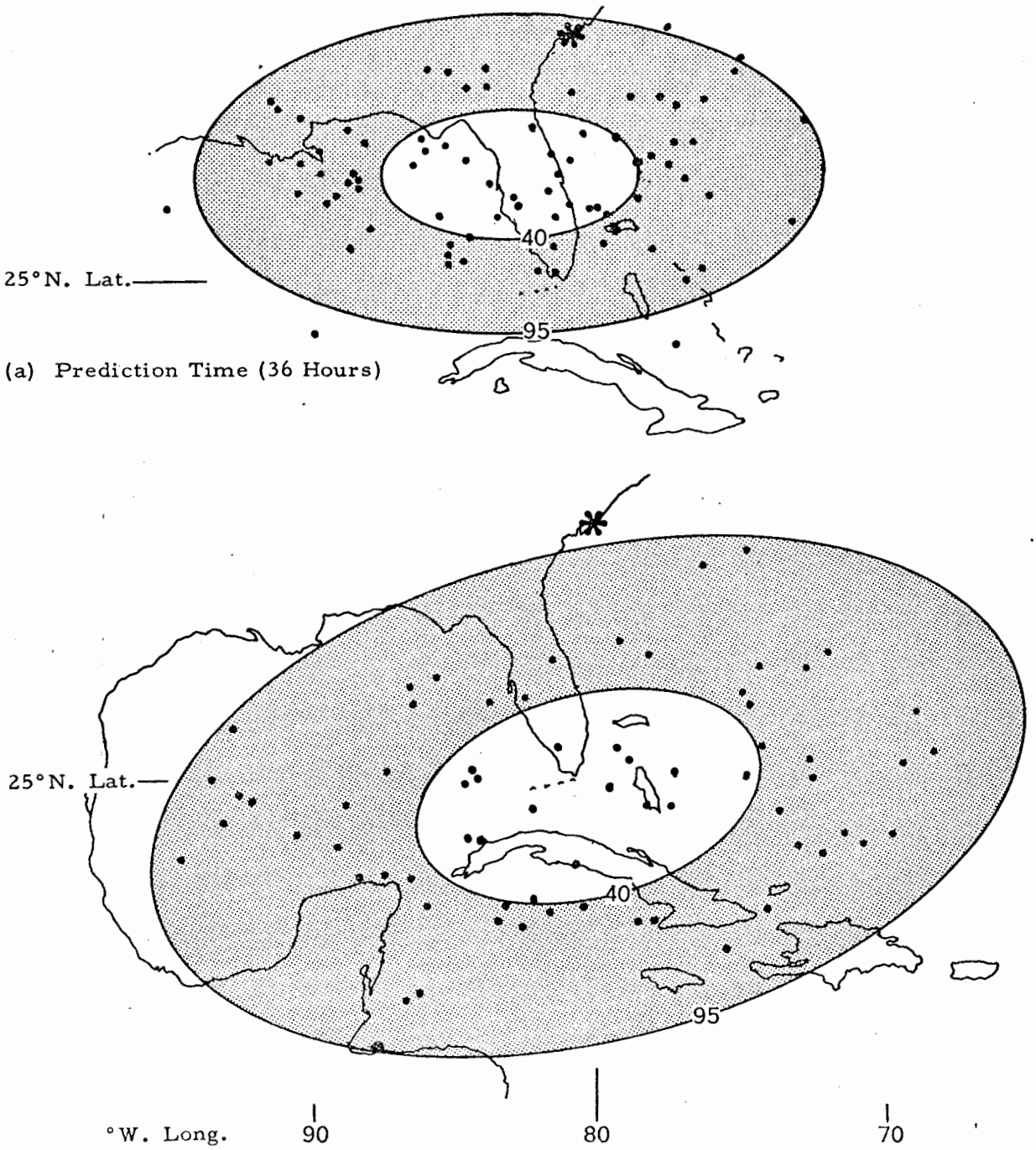


Figure 30. Hurricane and tropical storm strike probabilities in (a) 36 hours and (b) 72 hours at specific coastal cities. The 0.40 and 0.95 probability ellipses are centered on the distribution centroid. This distribution is based on data from storms which did strike or pass within two degrees latitude of the city shown, during the period 1886-1963. The distribution is not dependent on prior storm trajectory. This does not include hurricane and tropical storms within the ellipse area which did not strike the city.

HURRICANE STRIKE PROBABILITIES FROM CLIMATOLOGICAL DATA

OF SPECIFIED COASTAL CITIES

Norfolk, Virginia

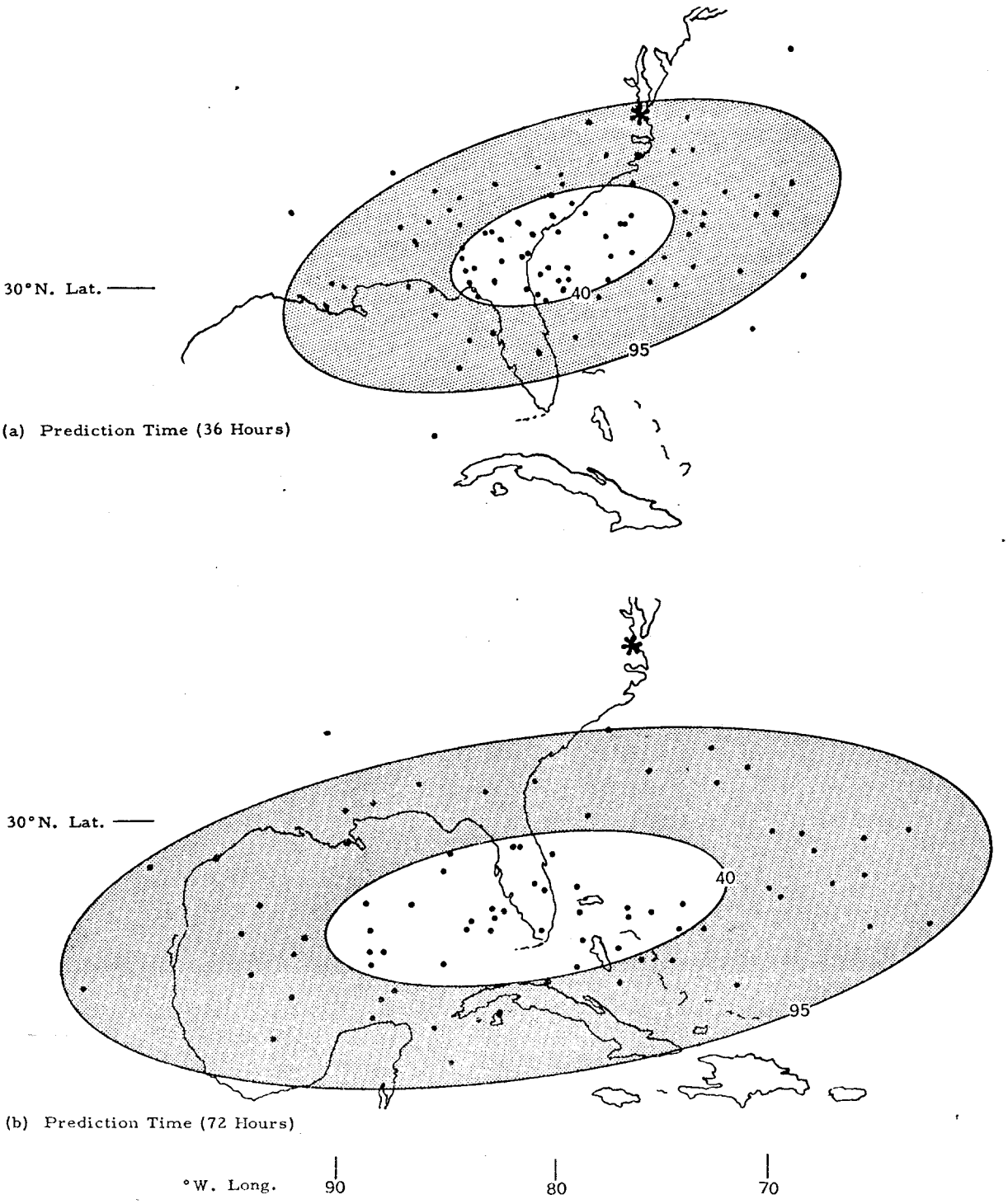


Figure 31. Hurricane and tropical storm strike probabilities in (a) 36 hours and (b) 72 hours at specific coastal cities. The 0.40 and 0.95 probability ellipses are centered on the distribution centroid. This distribution is based on data from storms which did strike or pass within two degrees latitude of the city shown, during the period 1886-1963. The distribution is not dependent on prior storm trajectory. This does not include hurricane and tropical storms within the ellipse area which did not strike the city.

HURRICANE STRIKE PROBABILITIES FROM CLIMATOLOGICAL DATA

OF SPECIFIED COASTAL CITIES

New York, New York

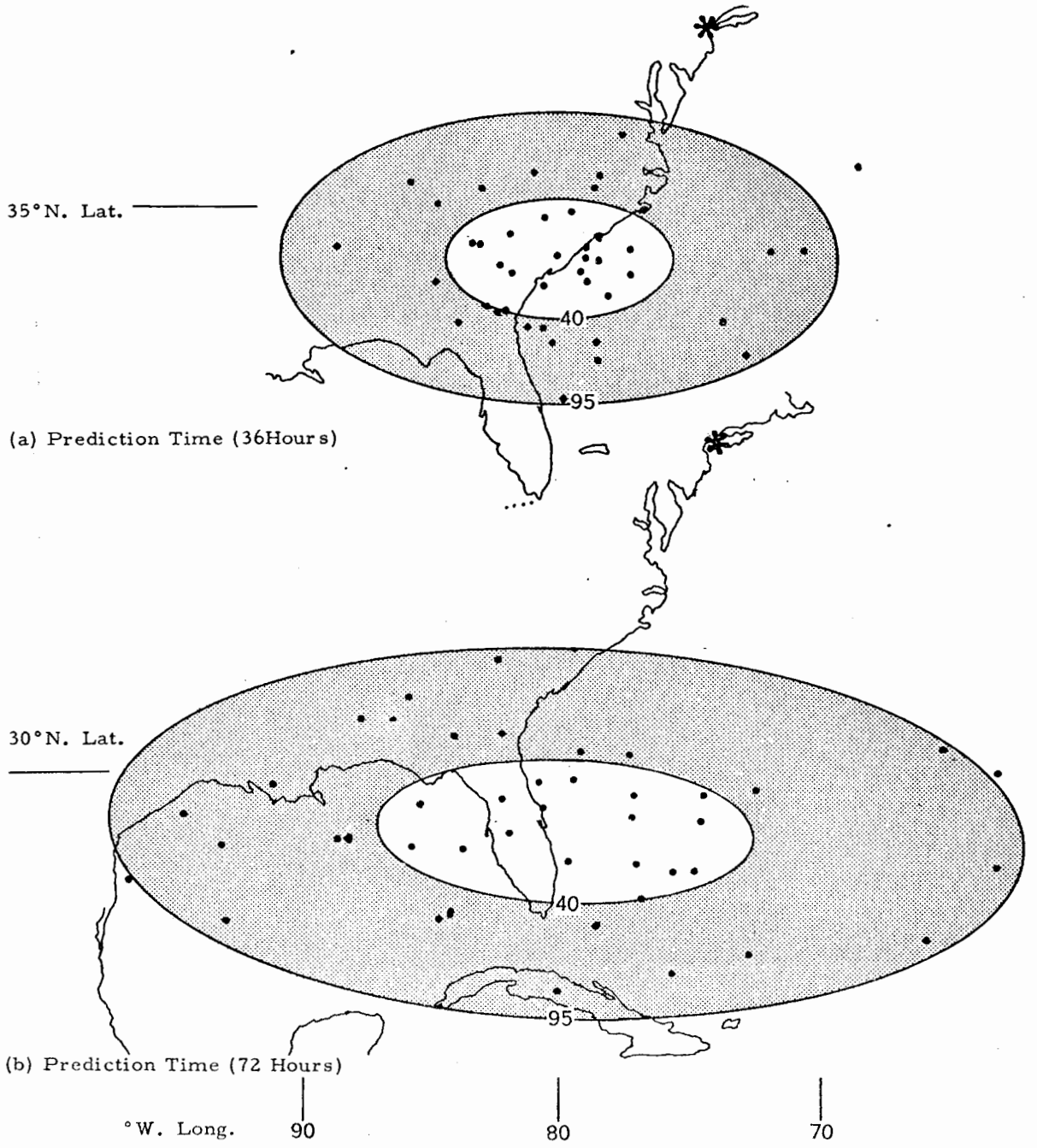


Figure 32. Hurricane and tropical storm strike probabilities in (a) 36 hours and (b) 72 hours at specified coastal cities. The 0.40 and 0.95 probability ellipses are centerd on the distribution centroid. This distribution is based on data from storms which did strike or pass within two degrees latitude of the city shown, during the period 1886-1963. The distribution is not dependent on prior storm trajectory. This does not include hurricane and tropical storms within the ellipse area which did not strike the city.

HURRICANE STRIKE PROBABILITIES FROM CLIMATOLOGICAL DATA

OF SPECIFIED COASTAL CITIES

Boston, Massachusetts

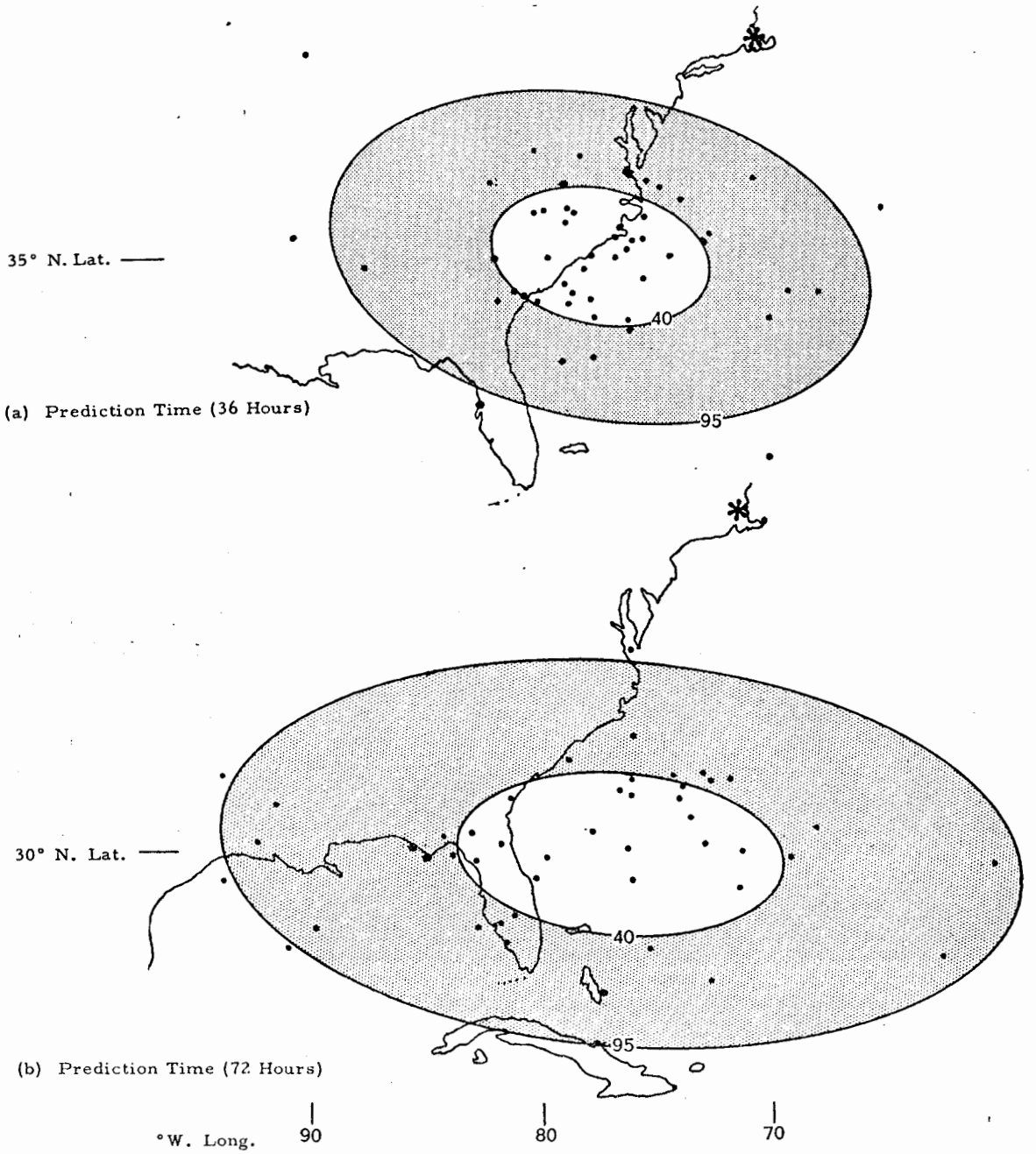


Figure 33. Hurricane and tropical storm strike probabilities in (a) 36 hours and (b) 72 hours at specific coastal cities. The 0.40 and 0.95 probability ellipses are centered on the distribution centroid. This distribution is based on data from storms which did strike or pass within two degrees latitude of the city shown, during the period 1886-1963. The distribution is not dependent on prior storm trajectory. This does not include hurricane and tropical storms within the ellipse area which did not strike the city.

HURRICANE STRIKE PROBABILITY TABLE

Square No.	Prediction Time (Hrs.)	Galveston, Texas	New Orleans, La.	Key West, Fla.	Miami, Fla.	Charleston, S. C.	Norfolk, Va.	New York, N. Y.	Boston, Mass.	Havana, Cuba	Kingston, Jam.	San Juan, P. R.
1	36	*	*	*	*	*	*	*	*	*	.004	.073
2	36	*	*	*	*	*	*	*	*	*	.086	.007
3	36	*	*	*	*	*	*	*	*	*	.069	*
4	36	*	*	.080	.030	*	*	*	*			
5	36	*	.003	.005	.010	.023	*	*	*			
6	36	*	.004	*	*	.033	.044	.021	.009			
7	36	*	*	*	*	*	.002	.010	.020			
8	36	*	*	*	*	.001	.004	.011	.017			
9	36	*	*	*	*	*	*	*	.001			
1	72	*	*	.004	.003	*	*	*	*	.008	.025	*
1	108	*	.001	.023	.022	.002	*	*	*	.023	.003	*

Figure 35

Note: * indicates a probability less than 0.000